WATER WORKS AND SEWERAGE

ABC ABP A GILLETTE PUBLICATION

November, 1935 — Editor — Vol. LXXXII. No. 11

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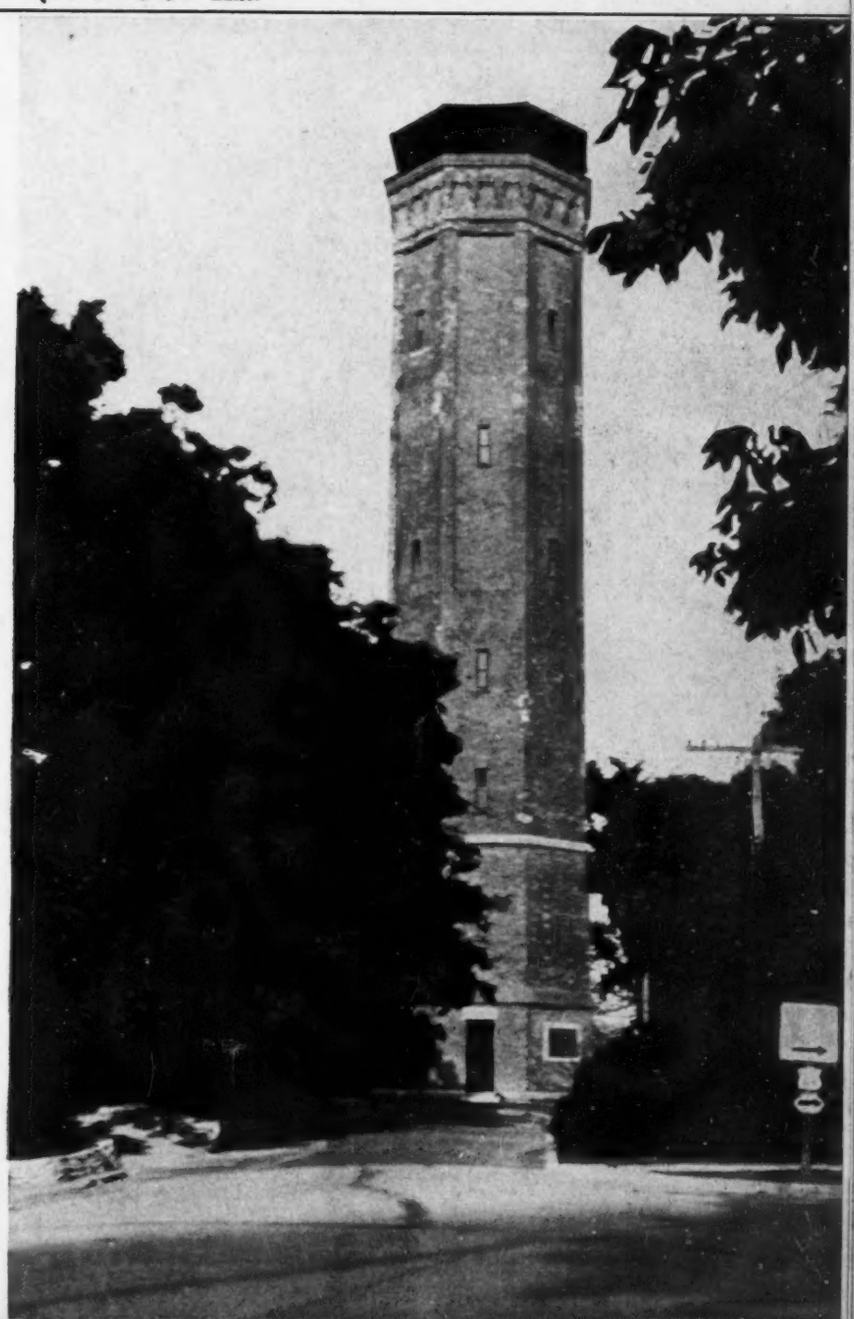

The Old Water Tower on the Lake—Winnetka, Ill. (1893-1935): The Old Octagonal Brick Tower Stands as a Landmark in a Picturesque Setting on the Lake Bluff. The Steel Work Enclosed Is Still Doing Duty as It Floats on the Main Above the Filtration Plant and Pump Station.

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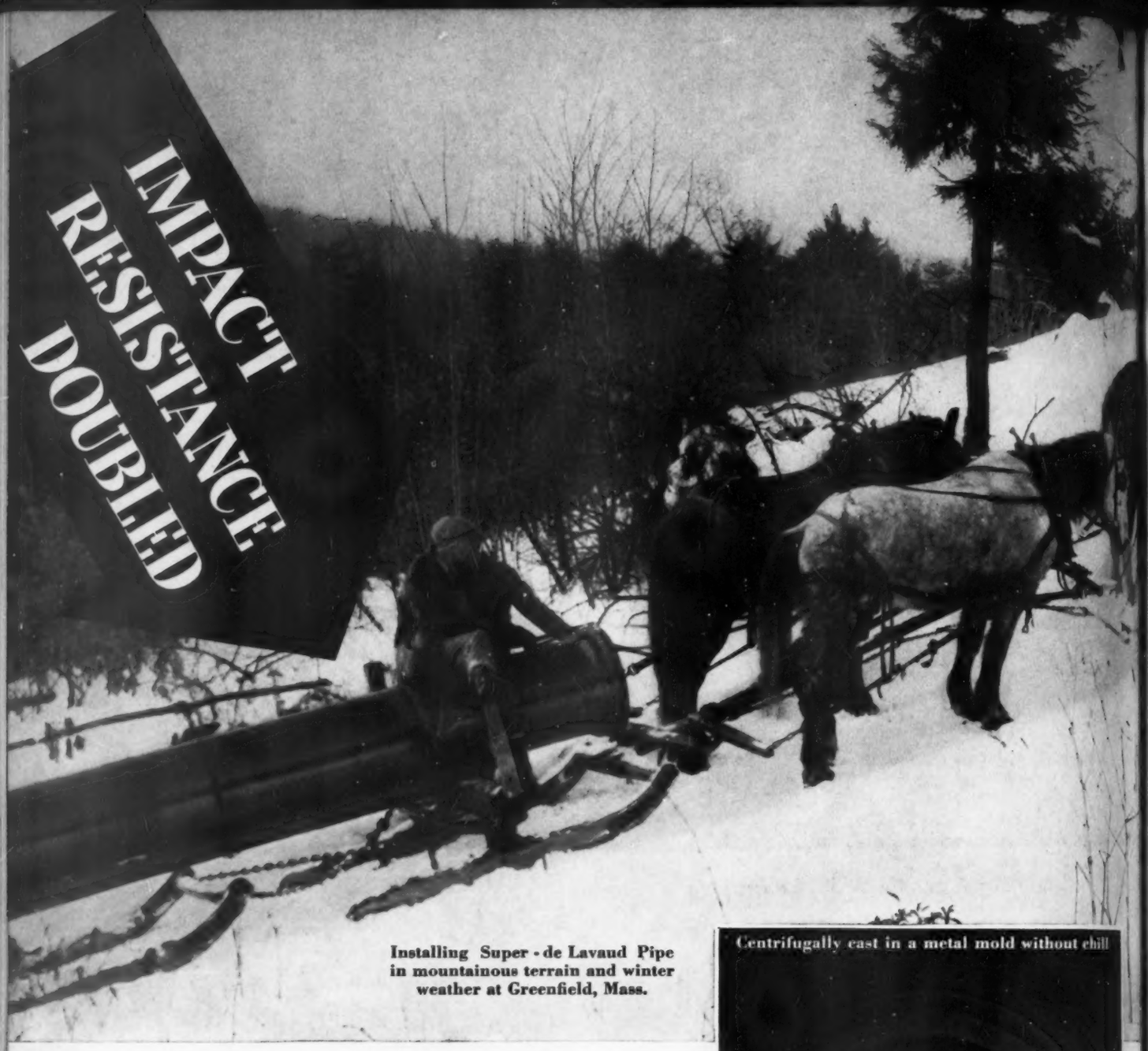

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WATER WORKS & SEWERAGE

L. H. ENSLOW,
Editor

FUTURE ARTICLES
To Appear in the Next and Subsequent Issues

"Unique Features of Milwaukee's New Filtration Plant" are to be described in a joint article by Louis R. Howson, Consulting Engineer and J. P. Schwada, City Engineer of Milwaukee, Wis.

"Garbage Disposal via Sewage Treatment" is a subject of considerable current interest. Cecil K. Calvert, Engineer-Manager of Waste Disposal Plants, Indianapolis, Ind., will disclose the results of large scale experiments, wherein ground or shredded garbage has been put through the Indianapolis Activated Sludge plant in varying quantities. The disclosures from this pioneering test are both interesting and illuminating.

"A New Method of Applying Copper Sulphate to Reservoirs" is to be described by R. F. Goudey, Engr., in Charge of Water Quality, Los Angeles. The scheme involves the use of pulverized sulphate of copper and a broadcasting dry-feeder located in the stern of the boat. The method proved labor saving, more economical, more uniform and efficient than the bag or spray methods.

"The Patent Situation in Sewage Treatment" is to be aired and discussed in an article by Paul Hansen, Consulting Engineer of Chicago.

"Evaluating True Costs in the Purchase of Pumping Equipment" presented by A. M. Brenneke, City Engineer and Supt. of Utilities, Dennison, Texas, is a discussion of suggested buying methods to be employed in drawing specifications, comparing pumps, and analyzing bids. Buying "pump performance" and therefore pumping economy, rather than pumping **capacity** for the lowest dollar per unit, is his theme.

"Sewerage Kinks": In a near future issue A. M. Rawn, Assistant Chief Engineer, Los Angeles County Sanitation Districts, will describe some of the "kinks" employed in operation and maintenance of the District's Sewerage system and treatment plants.

"The Odeeometer—Its Place in Sewerage Treatment" by Professor L. H. Kessler, of the University of Wisconsin, will describe the basic principles of the interesting "Odeeometer" (Oxygen Demand Meter) and its applications in quickly revealing oxygen balance and facilitating control of the activated sludge process.

"Practical Problems in Water Distribution" by E. W. Breitkrentz of Los Angeles, constitutes a discussion of experiences in construction, repair and operation problems in the Los Angeles Water Department.

"Specifications for Filtering Materials" will be discussed from the standpoint of basic requirements by John R. Baylis. He will present a set of suggested specifications which have been drawn from knowledge gained during several years of experimentation at the Chicago Experiment Filtering Plant and observations elsewhere.

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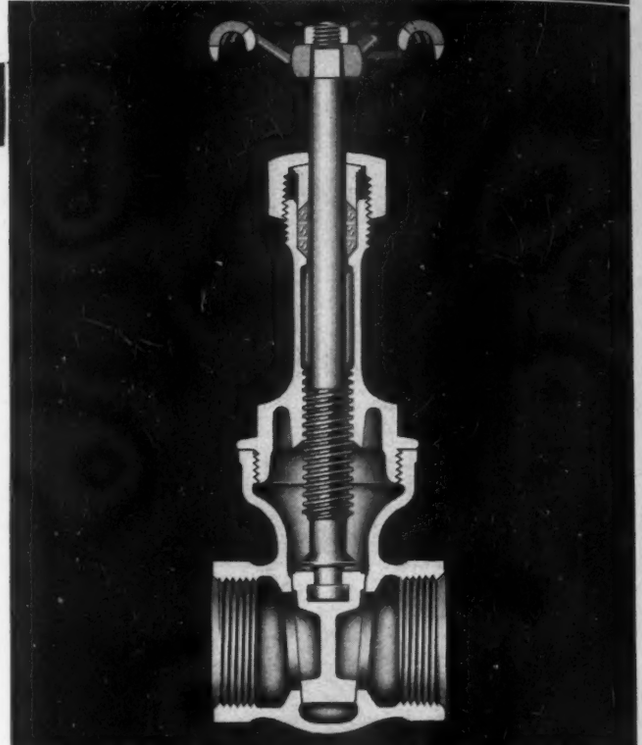

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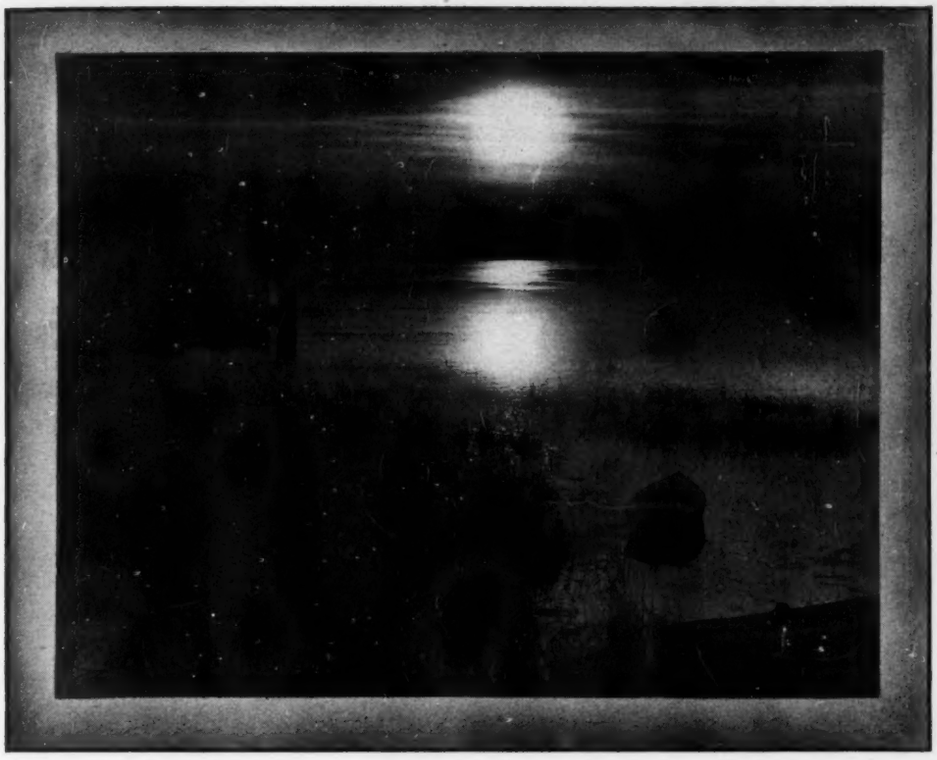

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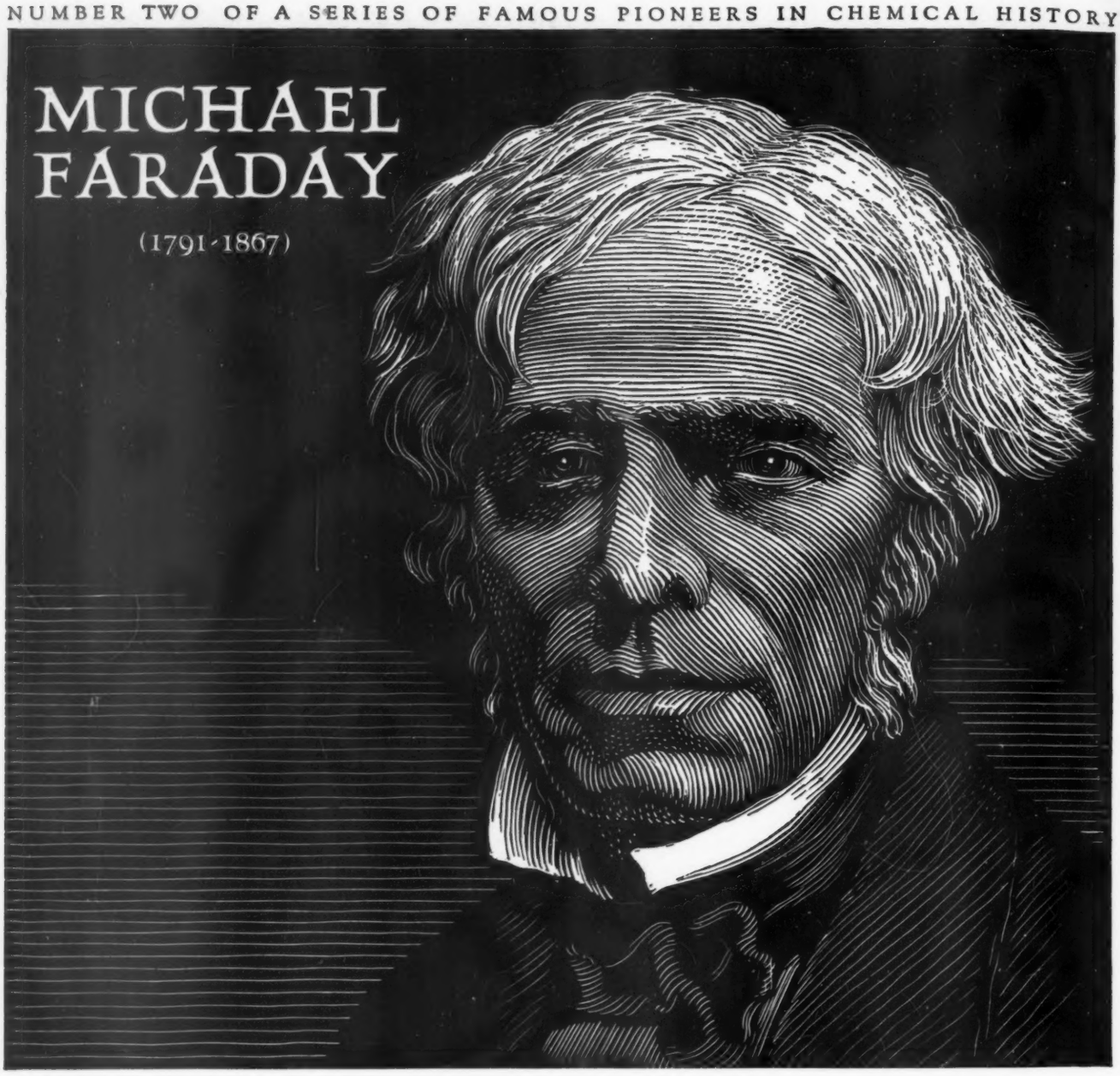

MICHAEL FARADAY, best known for his pioneer work in experimental electricity, was also a pioneer in the liquefaction of gases, notably chlorine. Thus, early in the 19th century, he laid the groundwork both for the modern electrolytic manufacture of chlorine and for present-day methods of chlorine distribution. Nearly a hundred years passed, however, before liquid chlorine came into its own as an important industrial commodity. Mathieson, first to manufacture chlorine products in the United States, has always been in the forefront of new developments in the production, distribution and efficient application of liquid chlorine.

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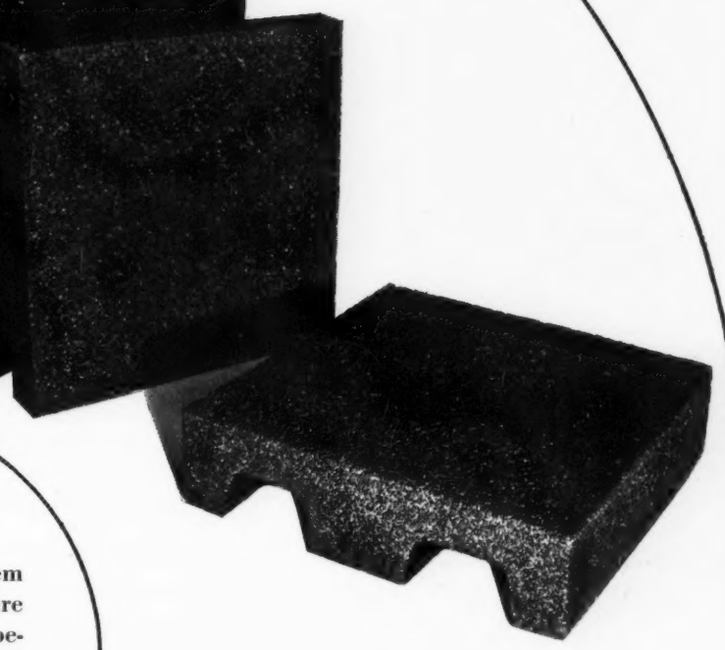

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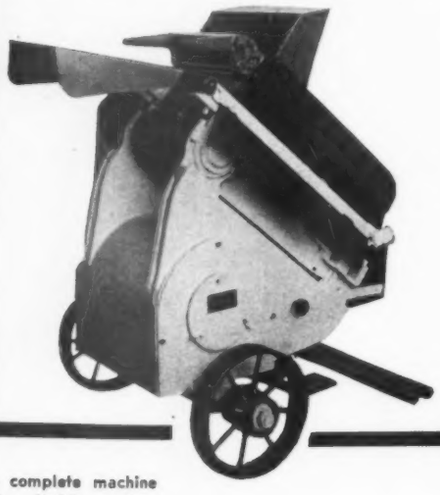

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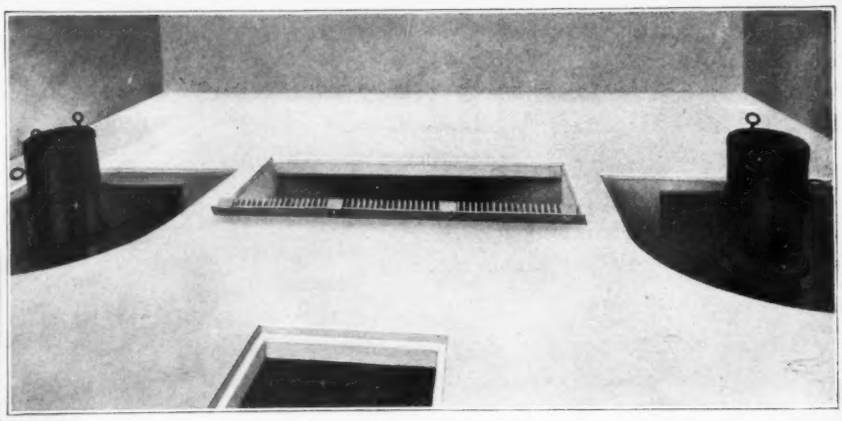

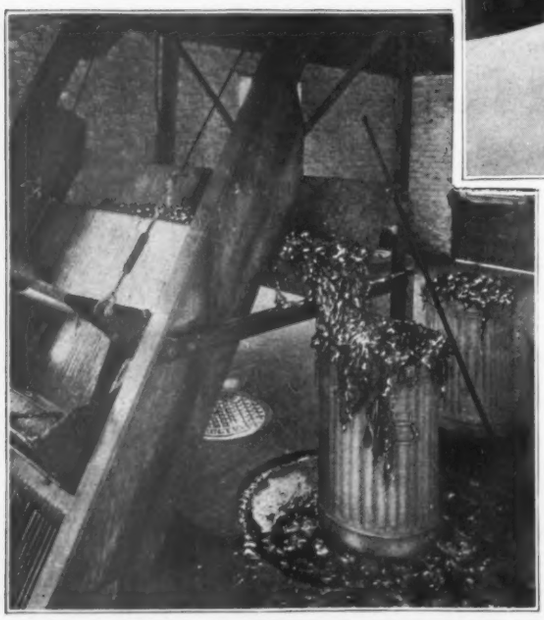

These views offer a striking comparison between the old and new methods of screening disposal. The picture at the left is typical of many of the earlier constructed sewage treatment plants. The screenings that have been collected in the trough and cans are waiting to be taken out and buried or incinerated.

The picture above is the way they handle the screenings problem at Durham, N. C. Two 25" "Chicago" Comminutors are installed in the raw sewage channel with the screen drums almost submerged. Raw sewage passes through small slots in the drums. The drums revolve. Small teeth on them cut up screenings under the raw sewage to pieces small enough to pass through the slots. Screenings are not removed nor handled in any way. They settle out with sludge.

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New York City's water supply system is internationally famous. According to the latest figures it contains 4,587 miles of pipe—enough to reach from New York to San Francisco and nearly half-way back again. These pipes vary in size from four inches to six feet. They distribute an average of about 900,000,000 gallons of water a day, or 130 gallons per day per capita. Under East Broadway there are some original cast-iron mains which have been in service since 1842. The aqueducts which bring the water from the reservoirs in the Catskills and the Croton watershed, some of them 100 miles distant, are marvels of modern engineering skill.

In spite . . . occasional trouble there

Excerpt from Editorial in NEW YORK TIMES

Section of 93 year old Cast Iron water main, still in service in New York City.

97.2% of New York's water distribution system is cast iron pipe

APPROXIMATELY two million lengths of pipe of which 97.2% is cast iron pipe distribute water to the five boroughs of New York City — 4587 miles of distribution mains which if laid in a straight line would reach from New York to San Francisco and nearly half way back again—this is New York's "underground empire." These mains distribute 900,000,000 gallons of water per day. Some sources are more than 100 miles distant. Capacity of storage reservoirs is 283,000 million gallons. The average percentage of cast iron pipe in the water distribution systems of the 15 largest cities in the United States is 95.6%.

Cast iron is the standard material for water mains. Cast iron pipe costs less per service year and least to maintain. Its useful life is *more than a century* because of its effective resistance to rust. It is the one ferrous metal pipe for water and gas mains, and for sewer construction, that will not disintegrate from rust.

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WATER WORKS AND SEWERAGE
A GILLETTE PUBLICATION
VOL. LXXXII NOVEMBER, 1935 NO. 11

Aerators and Coagulating Basins, Rapid Filtration Plant, Singapore, S. S.

WATER SUPPLY AND SEWAGE DISPOSAL AT SINGAPORE, STRAITS SETTLEMENTS

By ISADOR W. MENDELSOHN
Sanitary Engineer, New York, N. Y.

SINGAPORE is on an island at the southern extremity of the Malay peninsula, very near the Equator. It is the capital and most important part of the British crown colony of the Straits Settlements and its excellent harbor and location have made it one of the most important ports in the Far East. The climate is humid and hot. The average annual rainfall is 99.6 inches.

Singapore's population (475,000 in 1933) is made up of almost every Asiatic nation plus many other races.

The government of Singapore differs considerably from that of American cities in that the Municipal Council consists of members nominated by civic associations and chosen or approved by the governor of the Colony. The President of the Council—similar to a Mayor of an American city—is an English colonial official appointed by the governor and holds office for a period depending upon good behavior. He carries on the work of the city through heads of municipal departments who are also appointed by the governor. Among the departments are (1) Water; (2) Municipal Engineering, which includes branches of Sewerage; (3) Health.

Water Supply

Water is obtained from impounding reservoirs located on the island and in Johore, the neighboring Indian State. It is either slow sand or rapid sand filtered and chlorinated before passing to service reservoirs and the distribution system.

The two slow sand filtration plants, Bukit Timah Road and Woodleigh, were being operated at the rate of approximately 2.5 m.g. per acre per day.

The average number of days per run of these filters was 19 in the case of the Woodleigh plant and 33 for the other. The Woodleigh filters which were completed in 1910 have an area of seven acres, and both plants are on the island. Prior to filtration, 0.5 grain per gallon of lime (effective concentration) was being added to the water and the filtered water was being chlorinated at an average rate of 0.5 p.p.m.

Rapid Sand Filters

In 1929 the Gunong Pulai rapid sand filtration plant was completed. Two of the most recently constructed reservoirs and the filter plant are on the mainland more than 30 miles from the city. Water from the Pontian Kechil Reservoir (completed in 1931) is pumped against a 300 ft. head to the filters.

When the filtration plant was built, according to the design of the Paterson Filter Company of England, no provision was made for a coagulation basin, a mixing chamber or aerator for the iron impregnated water but coagulant was added to the water prior to filtration. Considerable trouble was experienced with mud-balls and shrinkage of the sand. When the beds were cleaned prior to the installation of aeration and sedimentation basins in 1932, a gelatinous mass of foul smelling mud composed of iron and aluminum hydro oxide permeated the whole sand bed, proving that the time provided for coagulation before the water passed on to the sand bed was insufficient and that coagulation had taken place in the body of the bed, thus producing "mud-balling" and shrinkage of the sand.

Now the water is aerated by sprays in two open concrete basins, then alum in amounts varying from 0.6 to 1.2 g.p.g, the water settled in two open basins, and then passed to the filters. The filter effluent flows to a clear water reservoir. The addition of alum is governed by a variable knife orifice operated by rate of water flow apparatus. With this treatment as much as 4 p.p.m. of iron in the raw water is reduced to 0.2 to

0.3 p.p.m. in the filter effluent, 50 per cent of the iron being removed by aeration, 25 per cent more by the coagulant and settling, and the remainder by the filters.

The filters have a capacity of 14.4 m.g.d. and are of the standard Paterson (British) type in a well constructed airy concrete building. Upon the health officer's recommendation, lime in solution is applied to the filtered water to add alkalinity to it, the powdered lime being controlled by a knife orifice operated by a rate of flow apparatus. The filtered water is chlorinated with liquid chlorine from a well known American made vacuum-feed machine at such a rate that 0.15 to 0.2 p.p.m. of residual chlorine remains in the treated water 10 minutes after its addition. Chlorine is shipped all the way from England in cylinders holding 65 lb.—200 of which are owned by the city.

Residual chlorine, alkalinity and turbidity tests are made at the filtration plant which is operated by British water works engineers. All other tests are made in the health department laboratory, as many as 60 samples a day being obtained. The actual cost of treatment of the water, excluding capital charges, was 3.9 cents per 1,000 gallons.

Pumping Stations

There are two main pumping stations in the water works system, Woodleigh and MacKenzie Road. The Woodleigh plant with steam engines is used continuously while the Diesel-Centrifugal and steam pumping units of the MacKenzie Road plant are worked in accordance with consumption demands. A third pumping station supplies chlorinated water from a reservoir to Seletar Village whose population consists of a working force of the city. Still another pumping station is worked, supplying salt water (chlorinated later) to a public swimming pool operated by the municipality and to a tank used by the Town Cleansing Division for street cleaning. In 1931, the average daily water supply of 19,448,400 gallons was made up as follows: From the rapid sand filters, 6,699,600 gals.; Woodleigh plant, 9,685,200; and, MacKenzie Road plant, 3,063,600.

The two service reservoirs—Fort Canning and Pearl's Hill—are maintained in continuous use and are fenced in. Of the more than 24,400 services on the system, over 23,800 are metered. Due to extensive tampering with meters by the natives, the Department made exhaustive tests on 20 different makes and types of meters and decided upon a type manufactured by George Kent, Ltd., as that most nearly meeting all the requirements.

The water rates are 16 cts. per 1,000 gal. for domestic users with a minimum monthly charge of 70 cts. Due to the depression in 1930 and since, the water consumption has decreased. There has been a decrease in the number of houses connected to the mains and a concomitant increase in the stand-pipe population whose average consumption amounts to 10 gals. per capita per day. Water is also being used with greater economy by all consumers.

Plans for future developments provide for increasing the capacity of impounded water reservoirs to a total of over 8,000 m.g.

Chemical and Bacterial Quality

Results of chemical and bacteriological analysis of the raw waters applied to the slow and rapid sand filters and of the filtered waters are given in Table I. The variations in chemical results are due in part to the use of analyses of raw water from only one of the reservoirs supplying each filtration plant. The less satisfactory bacteriological results of the rapid sand filter effluent as compared with the slow sand are due possibly

TABLE (I).—AVERAGE ANALYSES OF RAW AND FILTERED WATERS OF SINGAPORE

1932 (p.p.m.)	*Slow Sand*		*Rapid Sand*	
	Raw*	Filtered**	Raw*	Filtered**
Total Solids	30.7	31.8	38.5	38.9
Free Am.	.025	.026	.15	.05
Alb. Am.	.08	.05	.07	.07
Nitrites (N)	Absent	Absent	Absent	Absent
Nitrites (N)	.002	.002	Trace	.053
Chlorides	1.1	1.2	1.4	1.2
Iron	0.7	0.16	0.95	0.17
ph. H.	7.2	7.2	7.2	7.3
CO_2	2.2	2.4	4.	2.4
Lactose Fermenters[1]				
In 10 cc	36.2	1.6	36.8	9.5
In 100 cc	93.7	8.2	75.8	53.5

Note—*From one reservoir supplying each plant.
**Tap samples.
[1] Per cent of total samples showing positive test.

(1) to the long pipe line carrying the filtered water from the rapid sand filtration plant to the city, and (2) the smaller chlorine dosage to the rapid filter effluent.

Sewerage System

The whole volume of Singapore sewage, averaging 4,623,000 gals./day is passed through detritus and Imhoff type sedimentation tanks. Of the resulting effluent, 75 to 80 per cent is further treated on trickling filter beds and the remaining 20 to 25 per cent is partially purified in a bio-flocculation unit. The effluent from this unit, apart from a small proportion which is passed through on experimental filter bed, is mixed with the effluent from the filter beds. All the effluent is then passed through humus tanks before discharged to Alexander Road stream. Sludge from the humus tanks is dried on sludge beds and that from the other tanks is dumped on special grounds.

The sewage is pumped by electrically driven centrifugal pumps, from five stations, to the Sewage Disposal Works completed in 1930. The plant has coarse screens, detritus tanks, 32 Imhoff tanks, 55 circular trickling filters, humus tanks, sludge drying beds, and experimental units. The detritus tanks removed 12.2 per cent of the suspended solids from the crude sewage in 1932. The Imhoff tanks (2.65 hours detention at maximum d.w.f.) extracted 42.3 per cent of the total suspended matter from the crude sewage, and the ratio of organic to inorganic matter in the solids in these tanks was reduced from 5.4 organic to 1 inorganic before digestion to 2.04 to 1 after digestion. The scum in the sedimentation channels was being skimmed daily and deposited in the gas chambers, the scum in these being hosed daily. The direction of sewage flow in these tanks was being reversed weekly. Sludge was drawn off in small quantities at frequent intervals, at the rate of 1,177 gals. p.m.g. sewage treated. The moisture content of this sludge was 95.53 per cent. The sludge detention period is 40 days. Experiments on sedimentation of sludge by (1) addition of aluminum sulphate to detritus tank effluent at the rate of 3.5-4.5 p.p.m. and (2) agitation of detritus tank effluent with compressed air gave little effect.

The trickling filters contain 6 ft. of broken granite or coral and are 100 ft. in diameter. The tank effluent is applied by revolving arm distributors at rates of 40 to 90 gals./cu. yd. stone/day. They are rested for approximately 12 hours out of the 24. At first, ponding was a source of considerable trouble, the upper 12 inch layer being generally clogged. This layer is now washed in place by turning it over and hosing with a strong jet of clear effluent pumped from the nearby humus tanks.

The humus tanks provide two hours settling. The

The Rapid Filters and Operating Gallery, Singapore, S. S.

electric pumps used in desludging these tanks are used to pump the tank water for cleaning the trickling filters. These tanks produce a considerable reduction in suspended matter from the filter effluent as noted in Table (2).

To prevent the scum which appears on the water surface in the tanks soon after desludging from passing off into the effluent, filters of small lumps of coral were installed at the tank outlets, the effluent passing upward through them.

Sludge from the humus tanks was being dried on sand beds, and about two-thirds of it disposed of to the public for tennis courts, gardens, etc., the remainder being placed on dumpgrounds together with sludge from the detritus and Imhoff tanks.

TABLE (2)—AVERAGE OF DAILY ANALYSIS OF CRUDE SEWAGE AND EFFLUENTS, SINGAPORE, 1932 (P. P. M.)

Effluents	Ammonia Free	Alb.	Oxygen Absorbed in 40 hrs.	Susp. Mat.	Nitrites as N.	Chlorides as Cl	D.O. Absorbed in 3 days	pH.
Crude sewage..	44	12	117.8	402	...	480	...	6.9
Detritus tank...	..	..	...	353	...	...	...	..
Imhoff tank....	50	9	74.1	183	...	520	...	..
Experimental filter	8	1.1	13.2	9	20	550	6	..
Humus tank[1]...	14.3	1.4	15.9	13	16	570	12.9	..
Effluent[2]	5.4	0.9	11.0	6	13	560	5.7	..
Bio-Flocculation Effluent	52.	5.	38.7	62	...	550	87.9	7.2

[1]Represents a mixture of trickling filter and bio-flocculation effluents.

[2]Represents only trickling filter effluents, treated in humus tanks.

Experimental Work

Many experiments have been conducted on bio-aeration, bio-flocculation and sludge digestion. A bio-aeration tank was completed in October, 1927, 137½ x 52 x 5 ft. deep, with 10 channels having a total length of 1,365 ft. and a capacity of 198,000 gals. at 4 ft. depth. Mechanical agitation was furnished by 9 ft. diameter paddle wheels on two lines of shafting, each driven by 8 h.p. electric motors. From January to July 17, 1930, this unit treated an average of 188,000 g.p.d. of Imhoff tank effluent. The tank could not treat more than 240,000 g.p.d. The best results were obtained with an addition of 15 per cent of returned sludge, the aeration being followed by one hour's settling. Purification seemed to proceed even when the sludge was bulking. Chlorine added to the sewage entering the aeration tank at rates varying up to 36 p.p.m. adversely affected the biological life in the sludge. The results in general from the operation of this tank were unsatisfactory.

This tank was altered by dividing the 10 channels into two units. Four channels were converted to a flocculation tank with capacity of 76,200 gals. and six channels to a sludge reaeration tank of 114,000 gals. capacity. Two square Dortmund final settling tanks were provided 23 ft. 6 in. by 23 ft. 6 in. at the top, and 23 ft. 2 in. deep with capacities of 44,880 gals. A small electrically driven pump was installed for adding activated sludge to the flocculation tank.

Commencing October 4, 1930, the average quantity of Imhoff tank effluent treated was 853,776 g.p.d. The proportion of activated settled sludge added to the liquor entering the flocculation tank was only 1.62 per cent. The average detention period in the flocculation tank

View of Sewage Treatment Works of Singapore, S. S. (Alexandria Road Plant). Note the Small Activated Sludge Plant Using Paddle Wheels—Left Foreground. Sprinkling Filters with Rotating Distributors Are in the Right Background.

was but 1.92 hours. The purification results from this unit were 75 per cent reduction in suspended matter and approximately 50 per cent in oxygen absorption. In 1931 and 1932 this tank treated daily averages of 996,000 and 1,005,600 gals. respectively. Best results were obtained with addition of activated sludge to the incoming liquor to form 2 per cent of the mixture, as shown in Table (3).

The effluent from the bio-flocculation unit was applied to a 20 ft. diam. experimental trickling filter, similar in every respect to the large 100 ft. filters. The rate of dosing was considerably higher than with the large filters to which Imhoff tank effluent was being applied. The results of operation of this filter in comparison with results obtained from the large filter are given in Table (4).

TABLE (5)—RESULTS FROM SEPARATE DIGESTION OF NIGHT SOIL, SINGAPORE

	Moisture	Organic Matter	Inorganic Matter	Ratio Organic/Inorganic	Reduction of Organic Matter (Per cent)
Night soil as added	96.13	3.46	0.41	8.5	..
(a) Sludge from primary tank.	96.42	2.80	0.78	3.6	57
(b) Sludge from secondary tank	94.85	3.76	1.39	2.7	68

6,900 cu. ft. daily. The gas has a high colorific value and is suitable for generating power, containing 30 per cent carbon dioxide and 70 per cent methane. The gas was used to heat the digested Imhoff tank sludge with a view to destroying the bookworm larvae in it.

To digest the Imhoff tank sludge more completely, a separate sludge digestion tank was constructed. Although there was an 8 per cent reduction in bulk and 6.4 per cent in organic matter, better results are being sought by changes in the tank.

Nightsoil is collected from unsewered houses (largely by the city) and dumped at two sewage pumping stations. This has been found to affect the settlement of sewage in Imhoff tanks adversely. Experiments with six small and two large tanks used as primary and secondary digestion tanks indicate the possibility of obtaining a fairly completely digested sludge by treating nightsoil in this manner, the top liquor from the nightsoil digestion tanks being discharged to the crude sewage. The results are shown in Table (5).

Tests on intermittent chlorination of the Imhoff tank effluent as applied to the trickling filters (using up to 55 p.p.m. of chlorine) showed no apparent reduction in ponding nor improvement in filtrates. The effect was to reduce the odors from the filters.

TABLE (4)—COMPARATIVE RESULTS WITH TRICKLING FILTERS FROM APPLIED IMHOFF AND BIO-FLOCCULATION TANK EFFLUENTS, SINGAPORE

Effluent	Treatment	Gal. per cu. yd. per working day	Hours rested in ea. 24 hours	Chemical Ammonic Free	Chemical Ammonic Alb.	Results oxygen absorbed in 4 hours	Sus. matter	——P.P.M.—— Chlorides	Nitrates	3-day dissolved Oxy. Absorbed
Imhoff tank	Filtration and humus tank	52.8	11.3	6.2	0.7	10.8	6	570	12	5.5
Bio-Flocculation	Experimental filter and humus tank	192	8	9.6	.09	12.3	7	580	17	6.4

These results indicate that for approximately equal results the partially purified sewage from the bio-flocculation unit can be put through a trickling filter at nearly four times the rate that the Imhoff tank effluent can.

For gas collection tests, two Imhoff tanks were altered, each being provided with three gas chambers and two partially submerged gas hoods in each chamber. Sewage pumped from the sedimentation channels was discharged under the gas hoods to break up any accumulation of scum under the scum grids. The average amount of gas produced at first was 5,000 cu. ft., equivalent to 21.4 cu. ft. of gas per pound of organic matter deposited in the tanks. Later the amount was

TABLE (3)—RESULTS OF BIO-FLOCCULATION UNIT AT SINGAPORE IN 1932 (P. P. M.)

Activated Sludge Per Cent	Effluents	—Ammonia— Free	Alb.	Oxygen absorbed in 4 hours	Suspended matter
1.6	Imhoff tank.....	47	7.6	67.7	171
(Jan.-May)	Bio-flocculation...	49	5.6	40.9	73
	% purification....	..	26	40	57
2.	Imhoff tank.....	48	8.7	77.3	185
(June-Aug)	Bio-flocculation...	50	4.7	35.3	46
	% purification....	..	46	55	75
3.	Imhoff tank.....	55	9.4	79.7	197
(Sep.-Dec.)	Bio-flocculation...	57	5.7	38.5	60
	% purification....	..	39	52	70

Acknowledgment.—The writer wishes to express his appreciation of the assistance of Dr. P. S. Hunter and Mr. Reason in obtaining the foregoing data and in visiting the works.

Looking Across the Tops of Rapid Sand Filters, Singapore, Straits Settlement

PRIMARY ELEMENTS FOR SEWAGE AND WATER WORKS METERS

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A discussion of the fundamental principles, applications, and relative merits of the Venturi tube, the flow nozzle, and the orifice as applied to the measurement of sewage, sludge, water, and air.

L. D. Carlyon

IN MODERN sewage plants and water works, metering equipment is now recognized for the important part it plays in obtaining efficient control and operation.

Regardless of type, large meters and registering devices depend upon the so-called "Venturi" principle for their operation. This consists of producing a differential pressure which varies in a definite and known relation to the rate of flow. The differential pressure is mechanically converted into terms of weight or volume and is so indicated and recorded by registering equipment. The actual registers themselves are constructed to provide various combinations of indicating, recording, and totalizing features.

There are three commonly used devices, which can be inserted in fluid lines to produce the desired differential pressure. These are the Venturi tube, the flow nozzle, and the thin plate orifice. Each provides a reduction of the area through which the flow takes place, thereby causing an increase in velocity at this point with a corresponding localized reduction in pressure. The result is a differential in pressure between two areas of the Venturi tube, or on either side of the flow nozzle or orifice inserted in the pipe. Figure 4 illustrates the head differentials created by an orifice insert.

For a given installation the primary element is designed and constructed so that when the maximum rate of flow occurs, a definite maximum head differential will be produced. This varies from a water differential of less than 10 inches to one of more than 200 inches, dependent upon the fluid to be measured, the static pressure, the maximum capacity and the type of register.

*Mechanical Engineer, Bailey Meter Co.

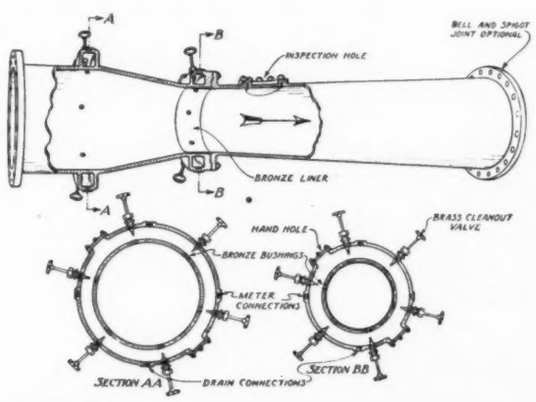


Fig. 1—Venturi Tube. (Handholes and Cleanout Valves Are Used Only for Measurement of Screened Sewage or Sewage Sludges.)

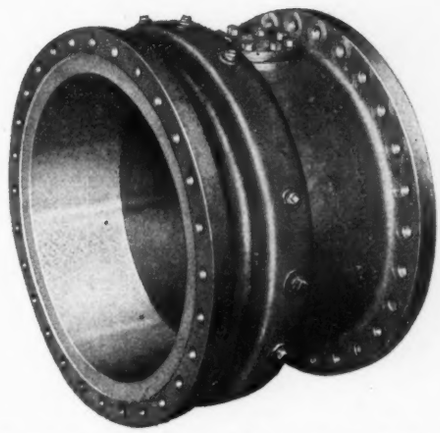


Fig. 2—Venturi Throat Section for a 56-Inch Line, Constructed of Cast Iron with a Machined Bronze Liner

Although any one of the three primary elements (Venturi, flow nozzle, or plate orifice) can normally be used, there will usually be one of the three which is best suited to meet the existing requirements. The selection is determined by a number of factors. These factors are to be dealt with in this article, with a view of better acquainting engineers, superintendents or operators with the more important considerations in selection of metering devices. It is hoped that some of the confusion concerning these devices which exists in the minds of some will be cleared away by the following discussion.

Fundamental Comparisons

The Venturi Tube

The Venturi tube has been used for years in connection with projects of the hydraulic and sanitary engineer. As illustrated in Fig. 1, it is designated with a short cylindrical section at the inlet end of the tube, which is cast smooth inside. The high pressure connection is made at this point into the piezometer ring (Fig. 1, Section AA).

Following the inlet section is an entrance cone of about 21 degrees total angle, which leads to the short cylindrical throat section where the low pressure connection to the meter is made through another piezometer ring. At the throat the tube is flanged, and has a handhole which permits inspection of the throat and piezometer holes, as well as accurate measurement of the throat diameter. An exit cone, known as the diffuser, follows the throat and has a total angle of approximately 5 degrees. This ends in a flange for connecting the tube to the pipe line flange.

In certain cases due to objection to the laying length of the long Venturi tube or possibly for reasons of cost, a tube is referred to as a "short Venturi" is used. It differs from the long tube primarily in that the angle of

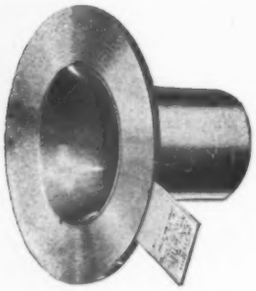


Fig. 3—Flow Nozzle

the exit cone is much greater (normally 13 to 15 degrees total angle), thus making the overall length much less than a long tube of corresponding diameter which is justified on the grounds that a smaller head loss is created.

The majority of Venturi tubes are fabricated of cast iron and are provided with brass or bronze liners in the throat which are machined smooth within close tolerances. Small tubes of from 1 to 2 inches diameter are often made of brass or bronze throughout and the entire length of the internal surface may be completely machined all over. Very large ones have been constructed of concrete or steel plate with a cast iron throat section having a machined bronze liner, such as shown in Fig. 2.

Flow Nozzle

In many respects the flow nozzle (Fig. 3) may be considered to be a simplified Venturi tube. The entrance consists of a gradual curve of approximately one-quarter ellipse which leads the fluid smoothly into a short cylindrical throat section. Thus the discharge jet will have no contraction and will be of the same diameter as the throat itself.

Installation of the flow nozzle is made by inserting it between a pair of pipe flanges. The high pressure upstream connection is usually made by tapping the pipe line approximately 1 pipe diameter back of these flanges, and the low pressure connection is made on the line at a point just opposite the throat section of the nozzle. For the measurement of water, air, sewage or sludge, flow nozzles are usually fabricated of bronze, the inside being very accurately machined.

Thin Plate Orifice

The thin plate, or sharp edged orifice, shown in Fig. 4 has been widely used for many years to measure the flow of fluids. In its simplest and most familiar form, the orifice is merely a hole in a flat plate which is clamped between flanges in the pipe line. It may be of 1/16 inch thickness or more, depending upon its diameter, and can be made of nickel, monel metal, steel or other suitable material. Flow meter literature abounds with results of thousands of experiments proving conclusively that the orifice operates on the same basic principles as does the Venturi tube and flow nozzle.

Referring to Fig. 4 it will be noted that there is a well-defined Vena Contracta (plane of greatest contraction) on the down-stream side of the orifice plate, just as is observed when the stream from a sharp edged orifice discharges into the open air. The pressure on the outlet side of the orifice varies along the length of the pipe with the velocity of the stream itself, the observed pressure being least (differential the greatest) when the connection is exactly opposite the Vena Contracta.

The location of the Vena Contracta remains constant regardless of the rate of flow for any one installation. It assumes a slightly different position, however, with different ratios of orifice diameter to inside pipe diameter. For a given ratio, its relative position is independent of pipe size. The high pressure upstream tap is made at approximately one pipe diameter back of the orifice, and the low pressure tap is made exactly opposite the Vena Contracta. Some manufacturers recommend that the taps be close to and on either side of the orifice plate; in this case it is necessary to obtain the orifice plate and the flanges as an integral assembly.

Factors to Consider

Before a metering element is specified or selected for a given project, six factors must be taken into consideration if the most suitable arrangement is to be secured; namely (1) initial cost, (2) installation, (3) accuracy, (4) reliability, (5) pressure loss, (6) capacity change.

The above factors may not appear in their order of importance, for the item which is of primary importance for any one application will vary with conditions peculiar to that application.

1. Initial Cost

The initial cost (purchase price) of the primary element may vary within wide limits. Figure 5 illustrates the approximate relationship between present-day prices of long Venturi tubes, short tubes, bronze flow nozzles, and thin plate orifices. It will be noted that for a given size, the price decreases in the order named. Without question the orifice has a decided advantage with respect to initial cost, being approximately one-ninth that of a long Venturi tube of corresponding size.

In the larger sizes, say above 24 inches, it is also possible to obtain orifices at prices from 20 to 25 per cent lower than those shown, by specifying a steel orifice plate having a nickel insert. This insert has the orifice hole machined in it and thus the more expensive metal is used only where it is essential.

Very large Venturi tubes become cumbersome and expensive. On this account large tubes are frequently constructed of steel plate or concrete at its location and only the throat section is purchased from the meter manufacturer.

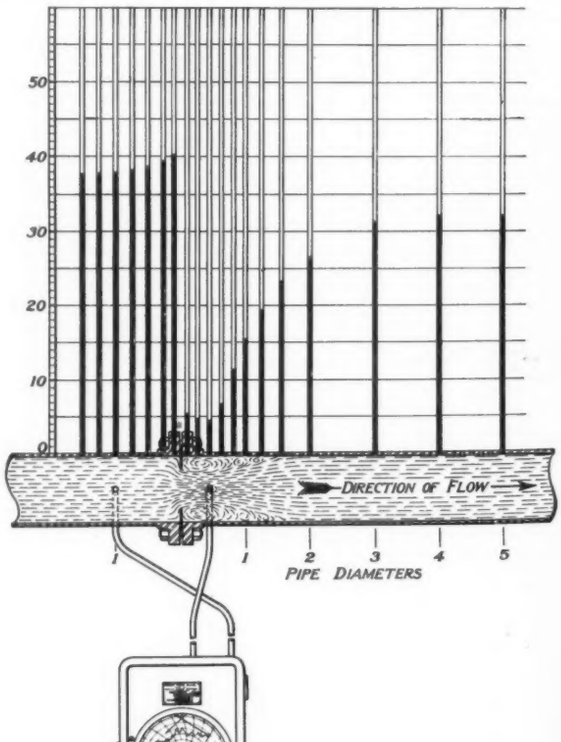


Fig. 4—Diagram of "Stream Lines" in a Fluid Flowing Through a Circular Concentric Orifice in a Pipe. Pressures Existing at Various Distances from the Orifice

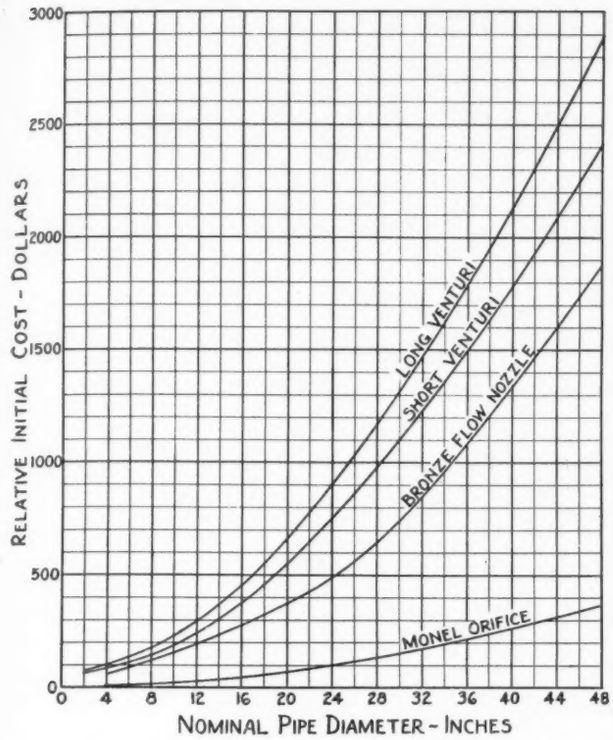


Fig. 5—Curves Showing the Approximate Purchase Prices (at Factory) of Various Types of Primary Elements. (The Curves for the Venturi Tubes Are Based on Weights Suitable for Use with Class A, B, and C Cast-Iron Pipe, and Do Not Include Handholes or Cleanout Valves Shown in Fig. 1)

From the standpoint of ease of installation, the orifice or flow nozzle would be selected in preference to a Venturi tube. They need merely be inserted between a pair of flanges in the pipe line, but considerable care must be taken to center the element properly, to make the pressure connections at the correct locations, and to see that there are no protrusions left on the inside of the pipe line as the result of making the taps.

The Venturi tube being relatively larger and much heavier, more time and labor is required in the installation. If the pipe line is an existing one, it will be necessary to remove one or more sections of pipe and to provide filler pieces of the correct length so that the tube can be made a part of the line. On a new project, however, in comparing the cost of installing a Venturi tube a credit representing the cost of a section of straight pipe of the same length, which otherwise would be required if a flow nozzle or orifice were used, should be considered.

Since the pressure taps are an integral part of the tube, these can be assumed to be correctly placed.

3. Accuracy

When installed under suitable conditions, the three primary elements are very nearly equal when compared on the basis of accuracy obtainable; namely, within 1 per cent of 100—plus or minus. Due to small inaccuracies introduced by the register mechanism, however, manufacturers normally extend a conservative guarantee that the reading will be within 2 per cent of 100 plus or minus. In actual practice the accuracy always falls well within the limits of the guarantee.

In order to insure accurate metering, all primary elements require a certain length of straight pipe preceding the location. For the Venturi tube, 5 to 10 pipe diameters are usually adequate. For the flow nozzle or orifice types this requirement is between 8 and 20 pipe diameters, depending on the ratio of orifice diameter to inside pipe diameter, and on the piping layout. Sometimes such requirements cannot be met due to the piping layout. It is under such conditions that the short Venturi tube occasionally proves most suitable because it is from 30 to 45 per cent shorter than the long tube of like diameter.

In order to preclude high readings on the registering device, the primary element should not be installed where the air or liquid flow is of a rapidly pulsating nature. Such a condition may be caused by water or sewage reciprocating pumps and by certain types of air blowers. It is sometimes possible to eliminate pulsations or dampen them materially but where pulsating flow is likely to be a problem this factor should be called to the meter manufacturers' attention; whereupon, specific recommendations will be made.

4. Reliability

It is essential that the primary element retain its accuracy after installation and that it also provide continuity of satisfactory service.

Screened sewages and sewage sludges present the greatest problem of measurement because of solid matter or gas which they contain. For this service the piezometer rings of the Venturi tube are equipped with cleanout valves (Fig. 1) which facilitate routine cleaning operations to maintain the openings free from obstructions. Connections should be made at top and bottom of each ring for venting accumulating gas or draining sediment. Handholes in each ring make the interior accessible.

At low velocities the throat section of the Venturi tube may act as a dam causing foreign material to settle on the bottom of the inlet cone and, thereby, affecting the accuracy. A condition of this kind can be largely avoided by the use of an eccentric Venturi tube (Fig. 6) which differs from the ordinary tube only in the eccentric shape of the converging and the exit cones. The fact that the bottom of the tube lies in one horizontal plane makes it easier for solid materials to be swept through the tube.

An installation of an orifice in a sewage line is illustrated in Fig. 7. Here also the eccentric type is of particular advantage in that solid materials pass through without obstruction. While there is even less chance of materials settling on the sharp edged opening than in the throat of a Venturi tube, there is a greater possibility of material collecting on the entrance side of the plate. For this reason it is desirable to provide a high pressure water supply into the pipe line (Fig. 7), for periodically washing off the face of the plate.

A common method for the prevention of plugged taps, and to keep the meter connections clean and free of deposits is to introduce a continuous trickle of clean water through the connecting pressure lines to create a slow current into the main pipe line.

Unless there is some especial factor involved, the flow nozzle should be avoided in metering sewage, because there is a tendency for materials to deposit in the throat section and to build up at the entrance. However, it has proved satisfactory where a means has been pro-

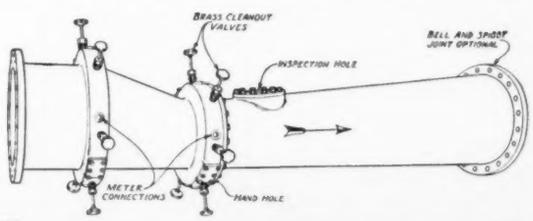


Fig. 6—Eccentric Type Venturi Tube for Sewage or Sewage Sludges

vided for flushing out the entrance and throat frequently.

Measurement of unscreened sewage should be avoided, except where there is no alternative, as for example when one community has its sewage treated in the plant of another municipality. The large heavy solids may cause greater wear and erosion on the primary element, and in the case of an orifice installation, there is the added danger of an object striking the plate with sufficient force to cause distortion.

Comparatively little attention is required for primary elements in air lines or fresh water mains, and all three elements will function indefinitely with practically no attention.

5. Pressure Loss

The differential head created by any of the three primary elements represents only a localized drop in pressure, most of which is restored upon resumption of normal flow a short distance following the primary element as is pictured in Fig. 4. It is important to hold head losses to a minimum, especially when capacities are large and available head is at a premium, or where pumping is involved and power requirements must be considered.

With the long Venturi tube, the pressure loss at any rate of flow is only approximately 15 per cent of the actual differential head produced by the element at that rate of flow, whereas with the short tube the loss is approximately 25 per cent.

The percentage loss created by orifices or flow nozzles depends upon the ratio of the throat diameter to the internal pipe diameter—the smaller the throat or orifice the greater the percentage loss. When designed for identical conditions of capacity, etc., the percentage loss will be virtually the same for both the orifice and the flow nozzle.

As a typical example, assume that a water meter operating on a maximum differential head of 53 inches of water is to be applied to a 20-inch main and to have a maximum capacity of 5,000 g.p.m. The loss of head created at maximum flow by the various elements as shown by the curve in Fig. 8 would be:

Long Venturi, 7.95 in. water (.15 x 53).
Short Venturi, 13.25 in. water (.25 x 53).
Orifice or Flow Nozzle, 29.15 in. water (.55 x 53).

With a flow of 2,500 gallons per minute (½ of maximum) the losses produced would be only ¼ of these values, because the differential head varies proportionately to the square of the rate of flow.

Although the curves of Fig. 8 apply only to the specific example, it can readily be seen that conditions exist where, by use of a Venturi tube, the reduced cost of pumping over a short period of time will more than offset the higher initial cost of the Venturi tube.

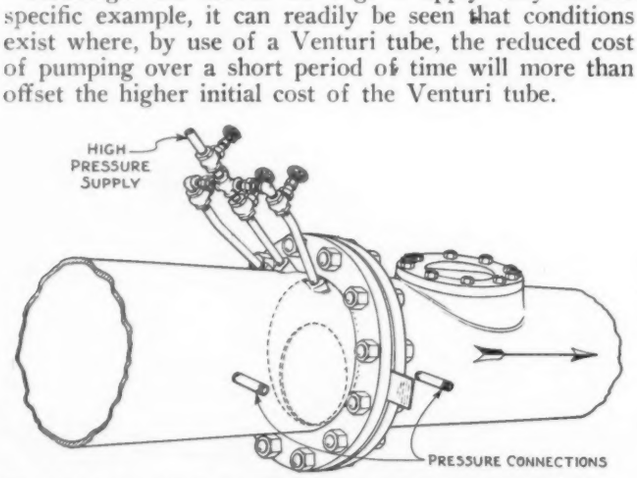


Fig. 7—Eccentric Type Orifice Installed in a Sewage Main, Illustrating an Arrangement for Washing Collected Materials Off the Face of the Orifice Plate.

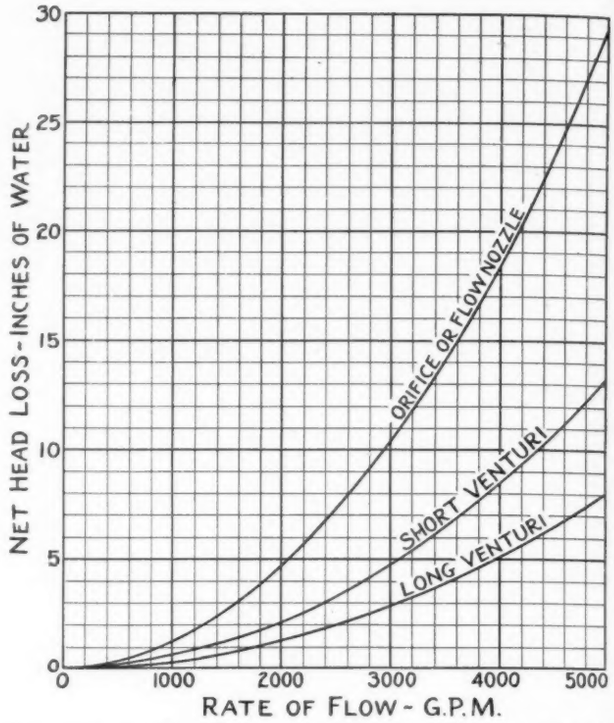


Fig. 8—Curves Showing the Net Differential Head Loss Created by Different Types of Primary Elements, Designed for a Maximum Differential of 53 Inches of Water, at a Maximum Capacity of 5,000 G.P.M., as Applied to a 20-Inch Water Main.

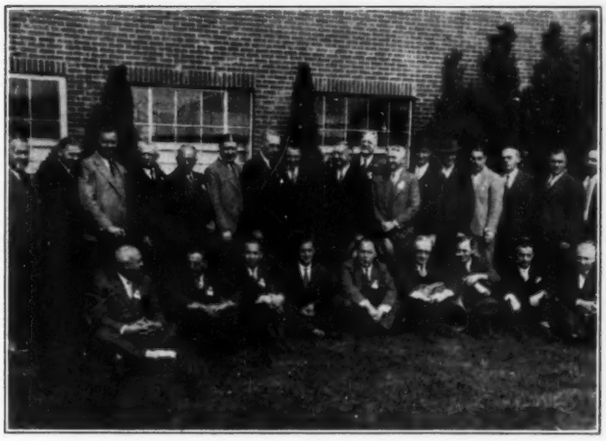
An existing meter installation may at some time require an increase in maximum capacity to meet the requirements of increasing quantities of fluid handled by the system. This may be accomplished in three ways—either by providing a new primary element, by modifying the old one to handle the larger capacity, or by increasing to the required extent the maximum differential head with which the register functions.

With the Venturi tube, the first two methods are costly, particularly in the larger size and therefore the register differential is usually increased. It should be borne in mind, however, that with this method, at rates of flow exceeding the original maximum capacity the pressure loss increases as the square of the flow.

When an orifice or flow nozzle constitutes the primary element, a new one can usually be installed at reasonable cost. Since such a change necessitates a larger orifice the pressure loss will be lower than for the original installation, notwithstanding the increased flows handled. This naturally cannot be accomplished in cases where the primary element originally installed is already near the greatest ratio for which it can be designed. It is necessary then to increase the differential head of the register and suffer the head loss entailed or else to provide a duplicate installation on a parallel twin line.

Knowledge of the principles described and intelligent consideration of the six factors outlined above will aid materially in obtaining primary elements which are most suitable for the particular project from the standpoint of both satisfactory operation and cost.

Final decisions can be made only when complete details and figures are available pertinent to the specific problems under consideration. Therefore, it is important to supply meter manufacturers with as complete data as possible concerning each contemplated meter installation, such as the type of fluid, maximum capacity, pipe diameter, pressure, and a dimensioned sketch of the piping layout.



Employees of Providence Water Department—Snapped at Scituate Filter Plant

PROCEEDINGS OF THE N.E.W.W.A. CONVENTION (Concluding Installment)

THE first installment of the report of the Proceedings of the 54th Convention of the New England Water Works Association, held September 17th to 20th at Providence, R. I., appeared in "Water Works & Sewerage" for October. In this, the concluding installment, is presented in digest form those papers and discussions which for lack of space in our October issue had to be held over for this issue.

Water Supply in the Tropics

"Water Supply Problems in the Tropics of Spanish America"—By GEORGE C. BUNKER, Consulting Engineer, Ancon (Canal Zone), Panama.

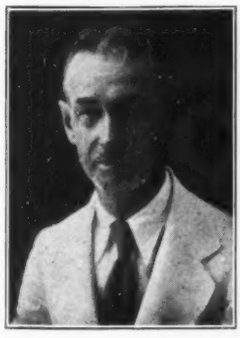
The author of the above interesting paper, which constituted a high light on the program, was recently in the States but having had to leave to supervise construction of the new reservoir, pipe line and filtration plant for Bogota, Columbia, was unable to present his paper in person. Mr. Bunker's paper which was presented in abstract by a former colleague, Theodore R. Kendall, was profusely illustrated by lantern slides, picturing the generally deficient water supply conditions in tropical America and a limited number of modern plants, of which Columbia has by far the greatest number.

Mr. Bunker touched on construction and survey difficulties in the tropics, created by heavy seasonal rains and jungle growths. He had found the general lack of basic data to be a serious handicap in effective planning. Sanitary regulations on water shed areas he said were absolutely lacking and difficult to enforce. Flashy streams had to be depended upon for the major supplies and were subject to extraordinarily high turbidity. Tastes and odors were another primary problem as were the water temperatures, which average 80 deg. F. in the lower altitudes. From a pathogenic consideration the chief problem was that of the prevalence of the organism which produced amoebic dysentery (Amoeba Histolitica) and its high resistance to all practical chlorine dosages. To cope with this organism filtration had proved essential.

Concerning filtration, uncovered basins and filters had proved satisfactory and economical, whereas covered reservoirs for the finished water were practically essential. The rapid onset of fermentation and gas lifting of sludge required rather frequent removal of deposits from coagulation basins, their cleaning often being necessary at 7 day intervals. Fermentation within the filter beds and accumulations of organic slime rendered air-wash highly desirable to loosen deposits and liberate odors. Procuring effective and rapid flocculation was relatively simple. Because of the warmth of the water a period of 4 minutes in the mixing chambers was generally ample. A chief operating difficulty was that of procuring and maintaining supplies of chemicals, all of which had to be purchased from the U. S. A. or Europe. The treatment costs were abnormally high, because chemicals laid down in South and Central American plants cost 100 to 500 per cent more than the same materials delivered in the States.

Mr. Bunker said, that in Spanish America water treatment had its beginning in 1904 in the Panama Canal Zone during construction of the Canal. Three modern filtration plants constructed on the Canal Zone since 1915 had stimulated purification developments in neighboring countries, of which Columbia was the most advanced. The earliest chlorination was at Barranquilla, Columbia, but a campaign against it by one or two local physicians caused its discontinuance. Probably as a result, this city thereafter constructed a modern filtration plant, designed by Pearse, Greeley and Hansen of Chicago. The Buneau-Varilla process of "Verdunization" had attracted considerable attention, but had proved a costly failure to one municipality which had tried the "magic-wand" chlorination process of Buneau-Varilla.

In Spanish America meterization had proved un-



George C. Bunker, Consulting Engineer, Panama City, C. A.

A. F. Dappert, Engineer, N. Y. State Dept. Health

popular, largely because owners of buildings were required generally to pay the water bills, rather than the tenants. An interesting comparison in consumption and waste showed that in Panama 300 gal./capita was taken by American homes, whereas native Panamans and West Indians made away with 100 gal./capita. Concerning the latter, Mr. Bunker side-remarked that he "wondered what they did with it."

Amongst recent developments, the first large municipal supply reservoir was now under construction at Bogota, Columbia, and a modern filtration plant was to be started shortly. Interestingly, a New England firm had the construction contract for the reservoir and the supply line contract had gone to the Lock Joint Pipe Company of New Jersey. (Fuller and Everett of New York are serving with Mr. Bunker as engineers on the Bogota project.—Ed.)

"Water Supply Protection During July Floods in New York State"—By A. F. DAPPERT, Sanitary Engineer, State Department of Health, Albany, New York.

Another paper of considerable interest was that by Mr. Dappert which set forth water-supply experiences and pictured (by lantern slides) the effects of the disastrous floods which swept central-southern sections of New York State in July. It seemed remarkable that no cases of disease had appeared as an aftermath which could be attributed to polluted water—an example of what modern disaster methods has been able to cope with. All water works men had been on their toes in respect to instituting emergency measures of purification and repair to damaged mains and structures. Much heroic work had been done and the availability of disciplined forces, such as the C.C.C. and T.E.R.A., had been especially valuable. Credit was due in no small measure to the Wallace and Tiernan forces which were sent into the field promptly by headquarters at Newark, N. J., to repair chlorinators and install emergency equipment.

The State Department of Health, which had promptly radioed a warning to boil all drinking water, also had 17 engineers working day and night in the flooded area, and the value of District Engineers, permanently located in the area, was thoroughly demonstrated. In 3 days this force had checked over 93 water works systems and had rendered aid to 42 needing it, involving the establishment of 16 emergency chlorinating stations and supplying operating supervision. Through the use of C.C.C. and T.E.R.A. forces, 10,000 private wells were chlorinated and a variety of relief service was rendered under direction of the Department engineers.

Some of the high lights of the flood damage included the reversal of river flow at Binghamton which swept the city sewage over the filter plant intake, but the treatment, including prechlorination, fortunately stood the test. Hornell was for a time completely without water when two supply mains washed out. The Delhi filter plant was washed away and the coagulation basis floated 1,500 ft. down stream. The Corning and Ithaca sewage plants were completely submerged.

Mr. Dappert commented that it was regrettable that many water works officials delayed calling the Department for assistance. In consequence the points most needing assistance had to be located by survey which involved avoidable delays.

E. SHERMAN CHASE commented on the recent experience in New York State as compared to those in 1913 when a somewhat similar emergency resulted in a water borne epidemic. It all went to show that the public was now less heedless of sanitation advice and that emergency measures had been greatly improved.

Chas. L. Pool, Providence, R. I.

Paul F. Howard, C. E., Boston, Mass.

"Improvements in Rhode Island Public Water Supplies During the Past 10 Years"—By CHAS. L. POOL, Sanitary Engineer and Chemist, and JAS. L. DILLON, Assistant Engineer, State Department of Health, Providence, R. I.

Mr. Pool presented a resume of betterments made to water supplies in Rhode Island. He stressed the point that the increased *rate* at which improvements had been made to Rhode Island supplies was the significant and most interesting disclosure of the analysis of accomplishments. Two major developments during the past decade had been the new systems installed by Providence and East Greenwich, R. I. There had been a notable general growth in chlorination of supplies and a better understanding and appreciation of the process. Improvements in water treatment practices and the better quality of water produced had been pronounced. Especial interest had been shown recently in pH adjustment to reduce corrosion troubles.

"The New Salem-Beverly Filter Plant"—By FRANK A. MARSTON, Metcalf and Eddy Engineers, Boston, Mass.

Mr. Marston presented an illustrated description of the 9.6 M.G.D. Salem-Beverly (Mass.) filter plant which was recently completed as a works relief (E.R.A.) project at a cost of $656,000 of which $305,000 represented the E.R.A. contribution. Starting construction in September 1934 (30 days, only, after filing applications) the project had been completed in less than a year. As the result, many cold weather problems in concrete mixing and handling, at 18 deg. below a part of the time, had to be met. Heated platforms and hot water had to be used in the mixing and $2,100 worth of tarpaulins had been required to protect the work by injection of steam under these covers. As far as practicable groined-arch construction (including the 4 M.G. clear water reservoir) had been employed, in order to reduce materials and increase labor. Except for foremen and key men all labor on construction of the plant had been drawn from relief rolls.

Mr. Marston stated that the chief problem in purification was that of color removal, tastes and odors, and main corrosion due to decomposition of organic matter therein. To combat the latter, ammonia-chlorine treatment was to be used. The plant (illustrated by lantern slides) was then in the tuning up stage prior to regular operation at a 6.6 M.G.D. rate to supply present demands.

Ground Water Developments

One session was given over to a symposium on ground water problems and developments. "Geologic Features of New England Ground Water Supplies" was dealt with by Professor Kirk Bryan of Harvard University who discussed the effects of glaciation on the yield and quality of New England ground waters.

Bayard F. Snow, C. E., Boston, Mass.

Ralph Horne, C. E., Boston, Mass.

"Public Ground Water Supplies in Massachusetts"—By F. H. KINGSBURY, Senior Assistant Engineer, Department of Public Health, Boston, Mass.

Mr. Kingsbury in an interesting historical review, aided by lantern slides, traced the progress and methods of ground water supply development in Massachusetts over a period of years, showing many interesting forms of infiltration wells and galleries. The first tubular wells had been put down in 1850 and grew rapidly in favor as indicated by the number of communities having adopted them. The most recent trend had been definitely to the gravel-pack type of well, Lowell, Mass., having 35 such wells under contract at present. Drilled deep wells had been decidedly unsuccessful in the state. The iron and carbon dioxide content of ground waters had been a source of trouble and increasing ammonia content with the iron increase had indicated the trouble to be caused by organic decomposition and reduction of iron ore deposits to produce soluble iron compounds.

"A Method of Determining Yield and Quality of Water from Tubular Wells"—By PAUL F. HOWARD, Consulting Engineer, Boston, Mass.

Mr. Howard described a method and equipment developed for testing the yield and quality of water from any individual well in a group of wells being pumped through a common suction line. The test could be applied at any point of draw-down during the period of pumping. Through use of a mercury U-tube monometer connected to a tube extending inside the casing, to a point below the water level in the casing, the mercury defection due to draw-down during the normal draught from that particular well could be observed and noted. The value to the suction header was then closed and a gasoline motor driven 1¼ inch centrifugal pump connected into the casing started. The discharge valve was opened gradually until the mercury monometer reading became the same as observed when the well was connected into the regular suction line to the well field from the central pumping station. An orifice meter and monometer on the discharge line of the test pump revealed the rate of yield of that particular well under the actual operating condition at the time. A hand pump was attached to the centrifugal pump for priming. To determine the draw-down the test pump was stopped and the water level in the casing determined by reading the defection of mercury in the U-tube on the well was deducted from that observed during the pumping test. Samples for analysis were drawn from the discharge during the rating test and thus represented true quality of the water from that particular well not ordinarily obtained by sample from such wells at rest.

"The Water Supply of a Public Institution"—By BAYARD F. SNOW, Consulting Engineer, Boston, Mass.

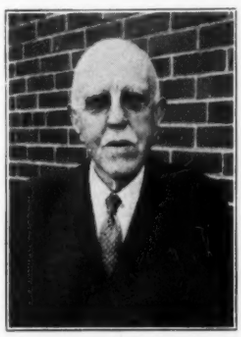
Mr. Snow described a well development project for a state institution and cited reasons for selection of a dug well which served as a ground water reservoir rather than adding more tubular wells to the existing system. Studies had been made to determine the draw-down and yield characteristics of both and the draw-down data plotted gave a straight line for the dug well as against a curve for the tubular wells. Mr. Snow was of the opinion that the dug well had decided advantages and that some form of automatic pump throttling device would prove advantageous to prevent damage to tubular wells pumped so heavily as to create an excessive draw-down. He had prepared rating curves on the 13 wells and had found yields to be dependent on the loss of head between the upper surface of the water cone and its lower tip.

"Procedure in Driving Shallow Tubular Wells"—By RALPH HORNE, Consulting Engineer, Boston, Mass.

Mr. Horne set forth some general rules to be observed in selection of location for well fields and general rules to be followed in making yield tests. Pumping tests should be continuous and made preferably with a diaphragm type pump rather than a centrifugal. He had found gravel pack superior to use of strainers and believed ample sand chambers should be installed ahead of pumps located at the end of a rising main. Employment of experienced well-drillers was practically essential.

HARRY W. CLARK asked to explain the source of iron in ground water, said that 41 years ago he had first made experiments in iron removal involving the use of coke contact beds and sand filters, the use of iron coagulant and permanganate. The Annual Report of the Massachusetts State Board of Health for the year 1899 contained the records and results attained. As to the source of iron, insoluble deposits of oxide of iron were reduced by decomposing organic matter in the absence of oxygen and the ammonia content was an index of the extent of degradation of organic matter. In the presence of organic matter iron ore was not readily precipitated by ordinary aeration and additional steps were necessary to remove it.

ROBERT SPURR WESTON said that his experience with iron removal dated back to 1895. Aeration alone frequently produced a very fine precipitate difficult to remove by filtration but contact beds would produce agglomeration of the fine particles. In the presence of organic matter the use of chlorine or permanganate had proved very helpful. Sometimes it was necessary to add lime also. Contact beds were frequently less efficient when aeration had been carried too far, especially in the presence of organic matter. For manganese removal a contact bed of pyrolusite manganese ore had been reported more efficient than coke or gravel. Another more modern method was the use of zeolites for iron and manganese removal. As to filters he had found a slow sand type operated at rates of 8 to 10 M.G.D. per acre satisfactory and the initial cost was not far above rapid sand units.



Harry C. Clark, Chemist, Boston, Mass.

Robert Spurr Weston, C. E., Boston, Mass.

The Canajoharie Waste Disposal Plant.

NEW ENGLAND AND NEW YORK SEWAGE WORKS ASSOCIATIONS HOLD JOINT MEETING

AT Schenectady, N. Y., on October 4th and 5th was held the initial and highly successful joint meeting of the New England and the New York Sewage Works Associations. A record attendance for sewage works associations was established when the registration list passed the 300 mark by almost a score.

Realization of the importance of such a joint meeting prompted 26 well repaid manufacturers to arrange exhibits of materials and equipment.

The House of Magic

A highlight on the program was the trip to General Electric's "House of Magic" made famous by radio's Floyd Gibbons, and his friend, G. E.'s Larry Hawkins, who was on hand to prove that the "large yarns" of Floyd Gibbons were not such yarns after all. Evidence —the one million dollar pop-corn popper in which high frequency radio waves entering the grains of corn, and there creating heat vibrations, resulted in the popping of the corn without external heat application. In fact, the popping corn was surrounded by an ice bath through which the other vibrations had to pass. This was but one of several equally magical demonstrations, which might be termed "tricks of the trade" from the research laboratories of "G. E."

Inspection Trip

On the second day of the meeting a visit was made to the Schenectady Sewage Treatment Plant and thereafter, by auto caravan, to the 40 mile distant novel plant at Canajoharie, N. Y., where the rubbish and garbage incinerator and the sewage treatment works comprise the unique combination plant, described by Henry W. Taylor in the March 1935 issue of WATER WORKS AND SEWERAGE. At the Schenectady plant sludge dewatering by filtration on an Oliver type vacuum filter and sludge cake pulverization by a Royer Disintegrater were demonstrated.

Entertainment

Another feature of this joint meeting was the entertainment provided for the attending ladies. A dinner, a floor show and dance was staged. At the dinner a special feature was the presentation by Toastmaster Morris Cohn of a past-president of the New York Association in the role of "Mon-sewer Dauber-Dapperdino," an artist of no mean ability with his "acti-

At the Schenectady Plant

Left: Sludge Dewatering with a Miniature Oliver Filter. Center: Chlorinator House That Made History. Here odor control by chlorination was first applied, likewise relief of filter ponding and filter fly control. Right: Royer Sludge Disintegrator at Work

Gordon M. Fair, President, N.E.S.W.A.

Morris M. Cohn, Pres., N. Y. S.S.W.A.

vated" crayon of "Chlorinated Sludge and Nuchar." Dapperdino entertained (incognito) with clever flash drawings, amongst which were lightning sketches of three members which are here reproduced as evidence of the ability of "Mon-sewer" A. F. Dappert—otherwise, a Senior Engineer of the New York State Department of Health.

Dr. Paul B. Brooks, Deputy State Health Commissioner, with his sample of radio skit used in promoting sanitation over the air, proved again the versatility of the Department's staff.

Business Meeting

Brief business meetings were held by each association. Election of officers takes effect at the Winter meeting of the New York Association held in January. The New England Association presented the following slate of officers which were unanimously elected.

President—Guy E. Griffin, Greenwich, Conn.

Vice President—Stephen M. Gage, Providence, R. I.

Sec'y.-Treas.—F. W. Gilcreas, Albany, N. Y.

Directors—John H. Brooks, Worcester, Mass.; LeRoy W. Van Kleeck, Hartford, Conn.

At the luncheon which followed, Mayor Fagal of Schenectady made a brief speech of welcome in which he said that he was sold on the need of sewage treatment and sanitation of the city. Further, that he was also sold on the man in charge of these functions in Schenectady—Morris Cohn, of whom they were proud, and were happy that the New York Association had seen fit to honor him as its president.

Papers and Discussion

Presiding over the first Technical Session was Gordon M. Fair, President of the New England Association, who introduced Dr. F. W. Mohlman, Editor of Sewage Works Journal, as the first speaker.

"Disposal of Sewage Solids"—By F. W. MOHLMAN, Chief Chemist, Chicago Sanitary District, Chicago, Ill.

In his excellently presented (illustrated) paper, Dr. Mohlman recounted the present day trends and newest practices in the handling and disposal of sludges in sewage treatment practice. He then went somewhat into detail concerning experiences, developments, and the selected methods to be adopted in the Sanitary District of Chicago program. One of the most important decisions had been the selection of vacuum dewatering of undigested sludge and incineration as the adopted method of solids disposal.

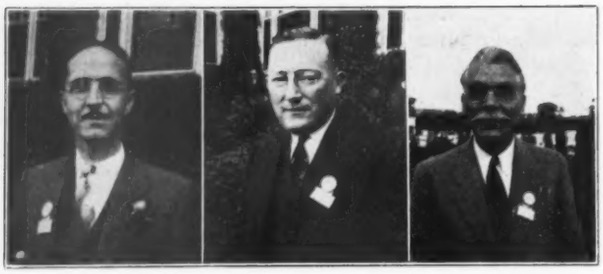
The outstanding developments in recent times, said Dr. Mohlman, had been the advances made in mechanization in sludge handling and disposal, which involved improved dewatering operations and the ability to odorlessly and economically incinerate the sludge cake. At Chicago, the original plan of digesting mixed activated sludge and crude solids in Imhoff tanks had proved impractical, because of the high water content of the digested sludge (94 per cent actual as compared with 87 per cent anticipated from experimental observations) and the staggering sludge digestion capacity required. Extensive studies of single stage separate digestion, in heated tanks on a large scale, had produced a sludge of 96 per cent water content. The overall costs of separate digestion had proved no less than that of providing Imhoff tank capacity. In 1932 their interest had been drawn to improving the efficiency and economy of sludge dewatering, and the possibilities of odorless incineration of mechanically dewatered undigested sludges. A 20 ton per day incineration plant was that year constructed as a pilot plant. Experimentation and trials had proved flash drying of the sludge cake and incineration feasible without odor, provided a temperature of 1,400 deg. F. was maintained in the combustion chamber. In 1934 the three power consuming hammer mills to beat up the sludge cake, being dried enroute to the incinerator, had been replaced by a Raymond cage-type mill. The result was a marked simplification and cost reduction in power required and heat exchangers effected an added saving. Now, a new plant with a capacity of 40 tons of solids (dry basis) per day was under construction at the Calumet plant and the program called for incineration of 400 tons of dry solids daily in the Chicago Sanitary District. Intensive and thorough studies had convinced them that elimination of sludge digestion and adoption of incineration in preference to fertilizer production to be the best scheme for Chicago conditions.

Dr. Mohlman pointed to the recent successful sludge incinerator installation of the Nicholas-Herreshoff type at the Dearborn, Mich., plant (see WATER WORKS AND SEWERAGE for September 1935) as evidence that incineration of chemically precipitated sludge was likewise a practical procedure. Unfortunately, said he, the dissimilar sludges at Chicago and Dearborn made comparison of cost data at the two plants difficult and, probably, unwise at this stage.

Other noteworthy advances had been the marked reduction in chemical costs in mechanical dewatering of sludges which elutriation (sludge washing) had effected. Stage digestion had constituted an advance which to his mind the possibilities of had not been sufficiently explored. The multi-stage digestion adopted by A. M. Rawn at the Los Angeles County plants, involving four stages with sludge return to the first stage, had not been accorded the attention deserved. There, a 15 day period of digestion at 85 deg. F. had proved ample.

Results from high temperature (thermophyllic) digestion at 130 deg. F. had been disappointing. More recently, however, an initial digestion at 130 deg F. for 5 days, followed by secondary digestion at 85 deg. F. for 7 days, seemed to hold promise of overcoming the odor and supernatant liquor problems which had

The Work of Mon-Sewer "Dapperdino" (Enslow-Cohn-Phelps) Art Collector's Note—Not for Sale!



Guy E. Griffin, Engr. of Teratment, Greenwich, Conn., and president elect of N.E.S.W.A. F. W. Mohlman, Editor, Sewage Wks. Journal, Chicago. Prof. Earle B. Phelps, Columbia University, New York

been encountered in single stage thermophyllic digestion.

Dr. Mohlman again referred to the possibilities which elutriation of digested sludges possessed when it was considered that in mechanical dewatering 71 per cent of the overall cost in conditioning was chargeable to chemical, whereas elutriation had reduced it to 49 per cent. For example, 8 lbs. of ferric chloride per 100 of dry solids had been thereby reduced to 3 lbs., i.e., 8 vs. 3 per cent ferric chloride requirement. Both at Washington, D. C., and Columbus, O., the process had been adopted and digested sludge cake of 70 to 75 per cent water content was to be taken from the plant for land disposal as such.

Commenting on centrifugal dewatering, Dr. Mohlman felt that capacities of centrifuges were too limited and the liquid discharged too objectionable. They at Chicago had investigated three types of centrifuge without satisfaction. Spray drying of sludge he felt had its limitations. Maintaining sufficient moisture in the dried sludge to overcome the dust problem, but not sufficient to cause heating in the stored sludge, was the practical problem. In Chicago a selective sieving of dried sludge had shown the "middlings" to be higher in plant food than the coarse or fines. Probably this richer material might be taken out and sold on the local and nearby market and the remainder burned.

In summarizing, Dr. Mohlman said that of all recent advances certainly the proving of incineration as being feasible and less expensive than digestion at the larger works, was outstanding. That incineration of a 65 per cent moisture filter cake from a chemical precipitated sludge was practical. Incineration had been adopted at Chicago because it was proven to be odorless; reduced plant area; was the most sanitary and practical method. Further, that power could be produced thereby and that it had proved to be the most economical of all processes investigated. Stage digestion, gas utilization in power development, the elutriation of *digested* sludge and mechanical dewatering constituted noteworthy advances in other instances.

In reply to a question, Dr. Mohlman said that the fly ash was taken out of the stack gases by a Cottrell dust precipitator and was flushed to a pond for separation.

"Cost Records in Maintenance and Operation"—By JOHN H. BROOKS, Superintendent, and ROY S LANPHEAR, Supervising Chemist, Sewerage Department, Worcester, Mass.

This worthy paper, presented by the senior author, is not subject to effective abstracting and little of it can be adequately reported here in condensed form. The reader is urged to watch for its appearance in Sewage Works Journal because of the clearness with which the authors have explained the thorough and efficient system of cost keeping which has been developed by the Worcester Sewer Department. To effectively understand the system the record forms accompanying the paper must be before the reader.

The "Work and Cost Ledger," said Mr. Brooks, was the mainspring of the system and the method of allocating costs under the main headings (1) Maintenance, (2) Construction, (3) Treatment, told the whole story. From the card records showing materials, labor and equipment rental charged against jobs, the ledger was posted weekly. Monthly reports taken from the ledger were reviewed by the Superintendent of Sewers. Mr. Brooks stressed the necessity for adequate cost accounting if the effective use of the budget system was to be had. A proper knowledge of cost simpressed appropriating officials and made it much simpler to obtain the budgest requested by the Superintendent.

GLEN D. HOLMES, Consulting Engineer, Syracuse, N. Y., speaking in high praise of the Worcester system of cost keeping, felt that it was as important to have adequate cost records of the sewerage utility as it was of the income yielding utilities. With more attention to and accurate knowledge of cost records, methods of improving and reducing the running operating costs could frequently be had without impairing efficiency—particularly was this true of power consumption.

ROY S. LANPHEAR, Superintendent of Treatment Works, explained the cost accounting methods as applied to sewage treatment at Worcester and said that he had never found it necessary to run beyond the budgeted allowance, and that made for happy relations. He referred to the completeness of records covering a period of many years at the Worcester plants which had been the cradles of sewage treatment. From these had come such men as Harrison Eddy, Julius Bugbee, Almon Fales, Chas. Agar, Stuart Colburn, Arthur Gorman and others which he chose to list as Worcester Sewage Works "Alumni."

"Some Fundamentals of B.O.D."—By EARLE B. PHELPS, Professor of Sanitary Sciences, Columbia University, New York City.

In customary style of the illuminating teacher that he is, Professor Phelps discussed the true meaning of the Biochemical Oxygen Demand values when applied in sewage treatment practice and stream pollution studies. The three really important elements to be considered in sewage treatment were bacteria, suspended solids and oxygen demand of sewage and effluents. For the last the Standard B.O.D. test remained the best measuring stick to reveal the important *property* of oxygen consuming matters present, rather than the exact oxygen demand value which was of lesser importance. In sewage treatment it was important to realize that sedimentation was effective in *reduction* of oxygen demand whereas biological oxidation or chlorination were effective in a further reduction by *modification* of the non-settling oxygen demanding matters present.

Professor Phelps discussed the constancy of *rates* at which the B.O.D. became reduced with increased time

N. L. Nussbaumer, Cons. Engr., Buffalo, N. Y. A. F. Dappert, Engr.-Artist, Albany, N. Y. J. C. Brigham, Sanitary Engr., Albany, N. Y.

Roy S. Lanphear, Supt. of Treatment, Worcester, Mass. Chas. C. Agar, an "Alumnus" of Worcester Sewage Works. John H. Brooks, Supt. of Sewerage, Worcester, Mass.

and biological effects observed in natural purification in streams, and likewise the depletion of dissolved oxygen in bottled up samples. The rate curves showing about 21 per cent decrease in B.O.D. from one day to the next seemed to hold rather universally constant for a variety of sewages and many industrial wastes. With each degree of temperature rise (Centigrade), within the range of biological activity, an increase of 4 per cent in the rate of natural purification could be observed as a general law. In stabilization of putrescible materials, Professor Phelps pointed out that there was little fundamentally different between aerobic and anaerobic effects, both being broadly speaking oxidation effects. In the latter, oxygen was taken from the compounds present, including sulphates and carbonates and organic bodies, and insoluble carbon was left behind. He compared the formation of coal deposits in nature with anaerobic oxidation of sewage solids and believed that at least 33 per cent of the volatil matter in sewage solids could be assumed to be non-digestible materials.

In chlorination processes the B.O.D. was definitely modified. In addition, the highly important *rate* of demand was reduced because of the change in the nature of the putrescible bodies by the chlorine. Likewise, the sterilization effect which destroyed or otherwise affected the behaviorism of many organisms was a factor in this effect.

Professor Phelps cited applications of the B.O.D. test in two important practical stream pollution problems taken before the courts. In each, oxygen depletion condition predicted from analytical data and dilution figures had been borne out later by fact. Studies had revealed that the stored up B.O.D. in the form of sludge deposited during cold weather on stream bottoms, and its release during summer conditions, had proved a factor of primary importance—one subject to correction by effective solids removal.

F. W. Gilcreas, in discussion, demonstrated the simplified colorimetric test for dissolved oxygen which he and Professor Phelps thought would make B.O.D. determinations far less cumbersome and time consuming than the present titration procedure with its many reagents. The test developed by Dr. Isaacs of Columbia University and improved by Mr. Gilcreas involves the addition of the drug amidol and sodium citrate, to reduce pH value, to a sample in a small bottle. A red color, developed during the next 30 minutes and indicating the concentration of dissolved oxygen, is compared against permanent standards. The test in Mr. Gilcreas' laboratory had proved accurate within 5 per cent and only excessive amounts of chlorine, hydrogen sulphide, iron or nitrate cause interference. As a field method the colorimetric test, to his mind, had especial value and numbers of tests per man hour could be increased tremendously.

"Unique Features of the Walden (N. Y.) Treatment Plant"—By Newell L. Nussbaumer, Consulting Engineer, Buffalo, N. Y.

Mr. Nussbaumer's paper describing the Walden plant and emphasizing its unique features has been printed in full in the October issue of Water Works and Sewerage. Of particular interest was the adaptation of an elevated C. I. sewer in order to eliminate one pumping station which would have been operating at a continuous expense. In another instance a force main designed as a syphon had reduced the pumping head by 50 per cent. "Everdur" metal gates had been employed to overcome corrosion and binding and screenings were shredded and discharged to the separate digesters. Gas collection and storage involved the installation of a gas holder new to the sewage field which is known as the "Dry Seal" type that functions without the troublesome liquid sealing of the floating cover and was more economical to maintain and operate. In the digester, heating coils of seamless copper tubing had been used. Automatic chlorination controlled by Venturi flumes was selected to insure continuously effective pre-chlorination without waste of chlorine.

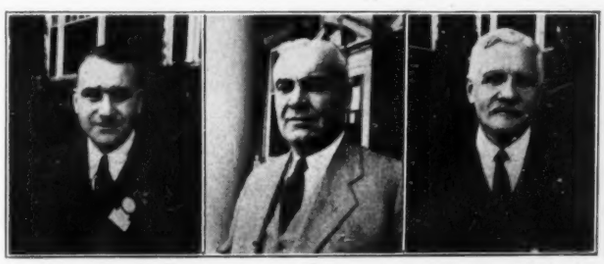
J. C. Brigham, Assistant Engineer, New York Department of Health, commented on the attractive appearance of the Dry Seal gas holder and the Walden plant as a whole. Of especial interest was the functioning of the syphonic force-main and the adaptation of a C. I. main run above ground on piers in order to avoid construction and operating costs of a pumping station.

Sun-Rise Breakfast

As is customary with the New York Sewage Works Association the Round Table Discussion was held the second day following the Sun-Rise Breakfast. In charge were Chas. C. Agar and Stuart E. Coburn who read questions taken from the Question Box and directed the discussion. Prior to the breakfast, Mr. Agar had shown interesting moving pictures taken at representative sewage treatment plants in New York State.

Sludge Conditioning—In reply to a question, Dr. Mohlman stated that ferric chloride or chlorinated-copperas remained the most efficient conditioners of sludges prior to mechanical dewatering. Lime with the iron was helpful in dewatering digested sludge but of doubtful benefit when dealing with the undigested material.

Chemical Treatment—To the question "Would effluents from chemical precipitation processes be as likely to encourage aquatic growths down stream as are nitrified effluents?" Professor Phelps pointed to the fact that in fresh water these were not, but in brackish waters (estuaries) organism growth was not dependent upon oxidized nitrogen but could make use of ammonia direct. L. H. Enslow commented that if chemical effluents went into lakes or ponds in which natural purification would result in oxidation of the ammonia salts in chemical effluents then, without question, algae could



H. W. Eustance, City Engr., Ithaca, N. Y. L. C. Purdy, City Engr., Schenectady, N. Y. Noel Statham, Pres., Industrial Chemical Sales Co., New York

be expected beyond the point of nitrite and nitrate production. It was a matter of ammonia vs. nitrate and how far from the outfall the effluent would travel before the ammonia was converted.

Activated Sludge Digestion—In heated digesters, Dr. Mohlman said, it was necessary to provide four cu. ft. per capita capacity for digestion of mixed crude and activated sludges. In Imhoff tanks 6 to 8 cu. ft. would be found necessary. Mr. Marshall of Chain-Belt Company reported that in separate digestion (heated tanks) 5 cu. ft. was the Wisconsin requirement. Mr. Holmes reported that the Newark, N. Y., plant had been designed for a 4 cu. ft. capacity, but even so, the conversion to two stage digestion had effected a marked improvement in the sludge, the gas and supernatant liquor. L. H. Enslow commented that in single stage digestion (heated tanks) San Antonio, Texas, had found 5 cu. ft. barely sufficient.

Dr. Mohlman felt that population ratings for digesters were very apt to be misleading. After all the correct index was the pounds of dry solids per cu. ft. which is a measure applied by S. A. Greeley of Chicago. In Los Angeles County (four stage digestion) this figure had run between 7.5 and 9.0 per cu. ft. per month, which seemed to give desired results.

Hazards to Sewage Works Operators—The question of likelihood of sewage works operators contracting diseases was presented to Professor Phelps who said that actual case history supported by theory would indicate that there was little or no danger, provided reasonable precautions be taken by operators.

Hydrogen Sulphide Generation—It was shown that neither sewage or industrial wastes were essential to hydrogen sulphide production in brackish water areas. In tidal swamps and marshy areas sulphates were frequently broken down by bacteria naturally present when other sources of oxygen became deficient and the temperature favored the organism.

Flooding Filters for Fly Control—Morris Cohn outlined the Schenectady scheme of allowing the sprinkling filter to fill during the night, followed by holding for quick discharge 24 hours later. The deleterious effect was but temporary, the stability of effluent (methylene blue test) reaching 14 days during the ensuing day. The flooding had been rotated, each unit being flooded at 10 day intervals and thus kept fairly clean. Mr. Lanphear remarked that flooding seemed to improve the filter efficiency at Worcester, except during and immediately after the flooding at 8 day intervals. The scheme had been practiced now during 3 summers. He considered flooding the practical solution in fly control and recommended small filter units be incorporated in future plant design in order to facilitate flooding with the least disturbance to the average quality of effluent.

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New Jersey Section of A.W.W.A. Organized

In New Brunswick, N. J., on October 30th, the newest Section of the American Water Works Association held its organization meeting at Rutgers University.

This initial meeting was attended by 90 members. Among this number several were new members, attracted to the Association as the result of the establishment of a New Jersey Section. Automatically the new section has to its credit 115 members of A. W. W. A. residing in New Jersey, most of whom had previously been affiliated with the New York Section.

S. F. Newkirk, Jr., Chairman

P. S. Wilson, Sec'y-Treas.

The Organization Committee presented the following slate of officers which were unanimously elected:

Chairman—S. F. Newkirk, Jr., Supt., Water Dept., Elizabeth, N. J.

Vice President—C. D. Moon, Mgr., N. J. Water Co., Haddon Heights, N. J.

Sec'y-Treas.—P. S. Wilson, Consulting Engr., Glen Ridge, N. J.

Director A. W. W. A.—W. J. Orchard, Wallace & Tiernan Co., Newark, N. J.

Trustees—G. F. Wieghardt, Hackensack Water Co., Wehawken, N. J.; W. R. Conrad, Consulting Engr., Burlington, N. J.; J. A. Carr, Supt., Water Dept., Ridgewood, N. J.

New Jersey Section

Indicative of the caliber of undertakings which the new section plans, the resolution which follows was presented and unanimously endorsed:

WHEREAS, the State of New Jersey is so situated geographically and as to the amount and location of its population that it has been found desirable and necessary for the municipalities of the state to take certain co-operative action, through state agencies and otherwise, in order to secure and safeguard suitable and adequate water supplies, and

WHEREAS, the manner of organizing and carrying on this co-operative action has been and still is the subject of discussion and consideration in the continued effort to satisfactorily meet the problems involved, and

WHEREAS, the manner in which these problems are met is a matter of direct and vital interest as well as a responsibility to the men engaged in the public water supply industry in the states, and

WHEREAS, the formation of a New Jersey Section of the American Water Works Association now places in the hands of these men an agency for exerting a united and beneficial influence upon the development of this subject, now therefore

BE IT RESOLVED THAT the Trustees of this Section, acting directly or through such committees as they may find it desirable to appoint, are hereby directed to give careful consideration and study to this subject with a view to determining upon a course of action by the Section which will beneficially assist and co-operate with the other existing agencies now endeavoring to meet these problems, and

That, after so considering and studying the subject the Trustees are to report back as soon as conveniently possible to the Section as to the course of action which they recommend, and

THAT copies of this Resolution are to be sent by the Secretary to the Governor of the State and to such other persons and organizations as may be concerned.

Considering the inclement weather on the 30th, an attendance of 90 constituted evidence of the interest shown in the creation of a New Jersey Section to serve the interests of water utilities and water works men within New Jersey.

A brief technical program and informal supper completed the first meeting of the New Jersey Section. That this newest of A. W. W. A.'s Sections has adopted a program and policy broad of scope and genuine in merit is indicated in the above resolution, now on record as its No. 1 Resolution.

FORGOTTEN METERS

By EARL A. SMITH
Chief Inspector, Badger Meter Co., Milwaukee, Wis.

The Author

A WATER meter, like a motor, must be scientifically designed, accurately built, and competently maintained in order that it may render the service for which it is intended. Also, like a motor, its efficiency is governed in a great measure on the same basic principles—lack of friction and exacting clearances.

Like the motor in your car a water meter operates more or less continuously, at various speeds, and under various loads. Its parts are accurately made and delicately adjusted. But, unlike the motor under the shining hood of your car, literally before your eyes and almost under your nose, the water meter all too frequently is hidden away in a dark, damp and dirty corner. Frequently it is covered with rubbish, littered with junk or submerged in muddy water. In spite of this it keeps right on functioning—after a fashion—under conditions that would prove disabling to any other type of motor.

As the meter functions it measures not only water, but it also measures revenue. To perform these tasks continuously and effectively it requires and deserves *some* attention just as an automobile motor requires occasional inspection, cleaning and overhauling. Use, neglect and abuse all leave their mark on its finely constructed mechanism. In time it becomes dirty, noisy and inaccurate—all to the detriment of the ability whose merchandise it dispenses and whose revenues it guards. Since most of us are more familiar with automobile motors than with water meters we shall try to draw an analogy.

Looking at Motor Production

Let's shift the scene to a busy machine shop manufacturing motors with pistons, piston rings, cylinders and other engine parts carefully machined to the thousandth part of an inch. Parts are finished, sent to the Inspection Department to be checked with delicate gages to see that they measure up to a predetermined standard. Only accepted parts are sent to the assembly line, free from grit and dirt, to be assembled into a complex, rugged and yet delicate motor that will function efficiently only when all parts are correctly made and correctly assembled.

This article is of peculiar interest, in that it comes from a machinist who compares his experience in the building and testing of water meters with his previous experience in building and testing gasoline and Diesel motors, aeroplane motors and machine guns—the latter while serving with the 291st Aero Squadron—U. S. A.

In this article the author makes some pointed and practical comparisons. First, similarity of exactness with which gasoline motors and water meters are manufactured and tested. Then, the marked difference in the subsequent care and attention given each while in service.—Editor.

The motor is then sent to the test blocks, oiled and greased, valve setting checked, spark adjusted, set in motion, given a trial run without load. Then the motor is run under load until the exhaust tells the tester it is loaded to capacity. After a few hours of this, the motor is stopped, checked for compression, valves checked and spark readjusted, speed taken. It is then ready for the brake test. Let's assume this is a 250 H.P. motor and that it must pull its load before leaving the factory. After passing this test it is sent into the field for duty.

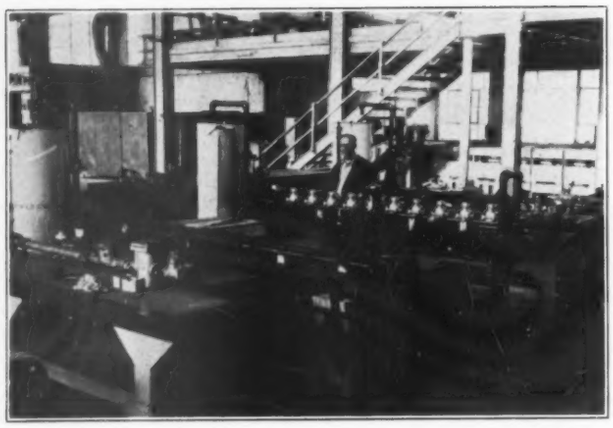
Assume that six months have passed. The motor lags, exhaust is dirty, it starts with difficulty. This tells the engineer on the job that something is wrong. The motor requires overhauling. Valves are ground, spark and valves retimed, springs tested, etc. After the overhauling, the motor again functions efficiently, perhaps as good or better than when it left the factory. Time again slips by. The same thing is done again, but the motor lacks its original pep. No matter what is done with it this 250 H.P. motor will not develop its original efficiency until it has been thoroughly overhauled and made new by rebore, new pistons, rings, valves, etc. Even so, more oil is now required, more gasoline is used. But due to generally worn parts less horsepower is developed. The engine that developed 250 H.P. at the shop now develops possibly only 220 H.P., and this in spite of the fact that it was given the best of care and frequent overhauling.

And Now at Meter Building

Assume another machine shop doing the same close work, and in some cases just a little closer. In the manufacture of water meters as in the case of motors, parts are sent to inspection and checked; but, checked just a little closer. Parts that pass rigid inspection are sent to the assembly line after a thorough cleaning, or after scientific plating of metal parts to guard against corrosion and electrolysis. In the assembly line these parts are assembled into water meters, ready for preliminary test for leakage, strength, capacity and accuracy to meet standards of the American Water Works Association. After these preliminary tests the meters are advanced to the final test for smooth and quiet operation and accuracy at all flows. The meter, like the motor, must meet definite predetermined requirements before it leaves the factory.

Assume that the meter, like the motor, tested O.K. and was sent into the field for duty—possibly to somebody's basement. Here it is allowed to run day after day—month after month, and year after year. As long as it continues to register nobody pays any particular attention to it, until it shows that it has not registered more than a few cubic feet or gallons since its last reading. In fact, it may have been neglected until it failed to register at all. In either case, only a fraction of the water used was registered with consequent revenue loss. The water, like gasoline and oil in the inefficient motor, was used. The difference is that the motor owner is out of pocket if his motor is neglected, but in pocket if his meter is neglected.

Examination of the meter will show dirt, corrosion, and worn parts. Its general condition will prove to any mechanic that for years dirt has been collecting. In that condition the meter could not register correctly.



A Well Equipped Meter Shop in a Large City. The Difference Between This and the Small City Shop, Being the Number of Shop Units

Gear trains and register may have been retarded or stuck for years, and yet it may have registered *something* until it just got so tight that it stopped entirely before the loss of revenue was noted by the meter reader.

We know that a meter properly built will test correctly and will seldom over-register, but it will continue to wear and slow up until it stops. The meter, like the motor mentioned, instead of performing its full task, was doing only a portion of it. Of course, the water utility is the sole loser, and why should the consumer be concerned?

The point is this: A meter, like a motor, is a complex piece of machinery. To work properly and register correctly it needs some attention. If it is neglected it cannot be expected to do its full task.

Good Maintenance Pays

To avoid loss of revenue meters should be taken out at intervals, cleaned and repaired say every time it registered so many thousands of cubic feet or gallons (depending upon the type of meter and service expected) rather than after stated periods, such as are required by state utility commissions.

To do this, and do it at a small cost, and up-to-date shop and skilled workmen must be available. Smaller communities that cannot afford such an organization should have reserve meters to install while defective meters are being overhauled at the factory which made them.

In the larger cities which can afford the necessary equipment, the repair department should be completely divorced from other municipal activities to keep the expenses down to the minimum. Or the work could be contracted out to a reputable plumber at a fixed charge for the removal and replacement of each meter. With some such definite plan of inspection and maintenance, a meter could be taken out, cleaned, tested and put back into service at very little cost. The increased revenue thus obtained from continuously efficient operation would result in a surprising profit each year.

Equipping a Meter Shop

For those who wish to install their own repair departments, factory trained help should be obtained if possible. The principal equipment, which can be purchased in the open market, would consist of the following:

Meter Testing Machine
Small Drill Press
Arbor Press
Speed Lathe
Hot and Cold Water Facilities
Acid Cleaning Bath.

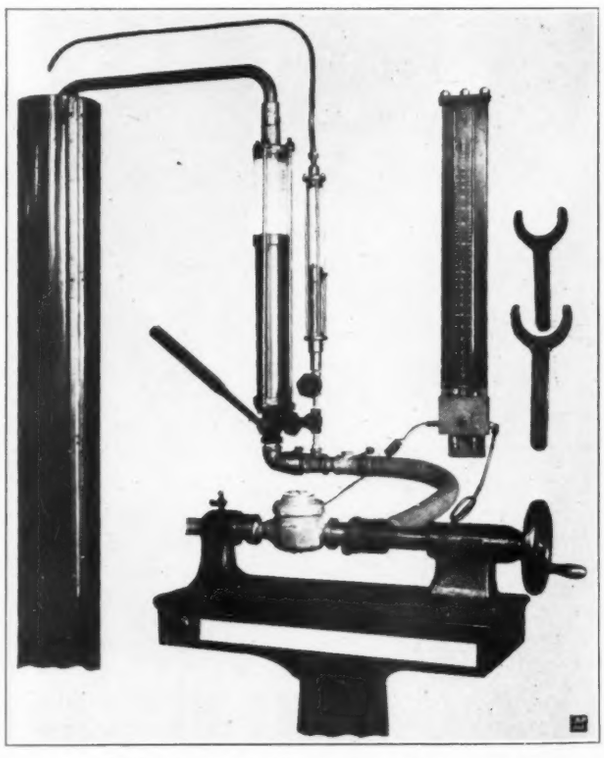
An assortment of steel balls should be on hand, both standard and oversize, to check the worn ball seats in chambers. And also the usual run of taps, drills and reamers.

Now let's assume our man who reads the meters reports that certain meters in a certain neighborhood have registered the amount of gallonage to be serviced. These should be tagged and reported to repair department. to be removed for overhauling and retesting.

Procedure in the repair shop would be as follows: The meter should be completely dismantled and each part tagged with a brass check of the same number. For instance, as the bottom is removed a No. 1 check is put on same. Then as the chamber comes out a No. 1 check is put on the top and bottom, and a No. 1 check is attached to disc. Hood, register and gear trains should also be marked in the same manner. Everything detached from this meter should be tagged No. 1. These parts should be sent to the cleaning department, cleaned and then returned for inspection. Gear trains should be oiled and checked for smoothness, chamber checked for wear by first using a standard ball as a gage. If this is loose, larger balls should be tried. These balls should run standard, .001, .002, .003, .004, .005 over or even up to .010 over. Special over-sized disc balls should be kept on hand to be fitted and lapped into worn chambers.

With such cleaning, checking and oiling, the repaired meter will test as good as a new one. But let a meter run down for years without attention and there will be a big repair bill on top of the loss of revenue already suffered.

Field experience, in examination of meters neglected in service, has proven that dirt and corrosion inside these meters made it impossible for them to have been registering correctly for an indefinite period before ex-



Meter Test Rack Used at the Factory. Mano-meter Glass on Right Shows Line Pressure and Pressure Loss Through the Meter at Various Flows. The Glass Tubes (Left) Register Rates of Flow During Tests. Cylinder (Left) Accurately Measures Water Passed for Comparing with Meter Register

amination. Both common honesty and sanitation urge the need of periodic inspection, cleaning and repairing of meters. It is a foregone conclusion that if consumers once saw the condition of the inside of their meter, they would not object to paying a small sum at intervals to insure clean meters and clean water.

If the health department of some cities, towns and villages knew what was really inside these meters after a long period of neglect they would insist on them being taken out at intervals and cleaned. Water works officials generally agree that it would be a good idea to service meters periodically but they believe that people would kick too much about the cost. A little educational propaganda showing basic facts, should overcome this opposition.

Many of the larger cities already have thoroughly organized and highly efficient meter repair shops, and some have ordinances requiring systematic inspection, cleaning and repairing of meters at regular intervals. These users find that systematic maintenance pays dividends. Unfortunately these provisions are not universal. In the smaller and middle size cities there are conditions ranging from complete neglect to fully efficient service. Many of these users seem to look upon a water meter as they formerly looked upon a watch—expecting to give 30 or 40 years of service without any attention whatever. And yet they do not expect more than five or six years of service from an automobile costing from 100 to 500 times as much as a water meter.

It is nothing unusual for water works superintendents to point with pride to meters in their repair shops that have been in service for 20, 30 and even 40 years. That these meters functioned after three or four decades there is no doubt, but that they measured accurately and that they should not have been replaced long since is open to questioning.

A check up and analysis of loss of revenue resulting from inaccurately operating meters that have long outgrown their usefulness would present a striking picture that would show that it does not pay to neglect meters nor to use them beyond a reasonable period of service commensurate with a period of usefulness expected from any other intricate mechanical device in continuous operation.

The fact remains that water meters require care and attention. Even with the best of care, and in spite of excellent materials and workmanship that go into their construction, meters do exhaust their accuracy long before they stop running entirely. A full realization of this and greater respect for the mechanics of water meters will be repaid in the form or increased revenue.

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California Sewage Works Association Holds 8th Annual Convention

THE 8th Annual Convention of the California Sewage Works Association was held on September 23rd and 24th. The first day was devoted to a brief meeting at Palo Alto followed by inspection trips to several treatment plants. On the following day two technical sessions were held in San Francisco.

A. M. Rawn, President C. S. W. A.

Action on Operator Licensing

The report of the Committee on Licensing recommended that the Association adopt the scheme of *voluntary* licensing of operators, similar in principle to the procedure followed by the Texas Division of the Southwest Section of A. W. W. A. The plan was approved and will be put into operation.

Technical Sessions

(A. M. Rawn, President-Elect, presiding.)

The first paper, by H. O. Banks, described the Palo Alto Sewage Treatment Plant and its operation.

John J. Casey, City Engineer of San Francisco, outlined the program under way for treating those portions of San Francisco sewage that now pollute its beach areas. The proposed Richmond-Sunset Plant will provide sedimentation separate digestion and chlorination.

J. W. Blackman, City Engineer, Long Beach, Calif., related experiences with hydrogen sulphide generated in the Long Beach sewers which had resulted in some damage thereto. To correct this trouble chlorinating stations were to be soon established at three selected control points and probably the adaptation of the Scott-Darcey process of producing ferrous chloride from chlorine and scrap iron would be the ultimate solution, either alone or in conjunction with partial chlorination. Mr. Blackman also reported on a process for protecting concrete sewers against gas attack which was under study and development at Long Beach. It involved a cold spray application of lead compound (three coats) at an approximate cost of 8 to 9 cents per square foot of surface treated.

Mr. Pomeroy, Research Chemist, Los Angeles Sanitation Districts, reported on and demonstrated a procedure that he had developed for the colorimetric determination of the hydrogen sulphide content of sewages. The method consisted of the introduction of reagents which yielded methylene-lue in proportion to the hydrogen sulphide present, and comparing the color with standards. The test was capable of determining sulphide content between 0.1 and 20 parts per million and was accurate within 10 per cent.

The effects of industrial waste pollution at Stockton were disclosed as the result of water course studies made by the State Department of Health. Such wastes discharged into Stockton sewers had resulted in a treatment plant loading three times that indicated by volume of flow treated. A valuable table, prepared by the Engineering Division of the State Department of Health, listed population equivalents for a variety of industrial wastes.

The last session of the meeting was devoted to a symposium on "Operation of Gas Engines on Sludge Gas," that revealed the practical potentialities which power production from sludge gas offers.

Officers Elected

The following were elected to office:

President—A. M. Rawn, Los Angeles, Calif.
Vice President—E. A. Reinke, Berkeley, Calif.
Vice President—R. F. Goudey, Los Angeles, Calif.
Sec'y.-Treas.—F. D. Bowlus, Los Angeles, Calif.
Board of Control—C. G. Gillespie, Berkeley, Calif.; H. F. Gray, Oakland, Calif.

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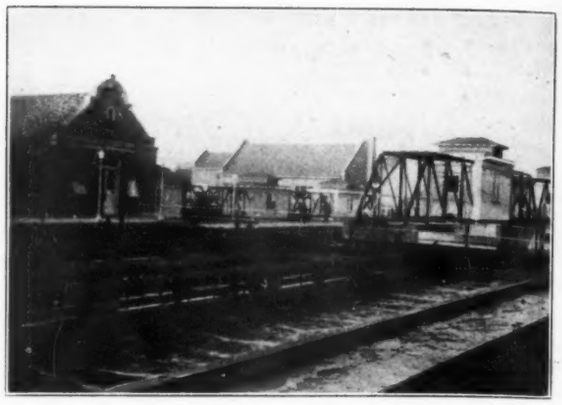
Roy Phillips Honored Again

Roy Phillips, City Engineer of Meadville, Pa., and immediate Past-President of the Pennsylvania Sewage Works Association, has recently been made President of the Engineering Section of the League of Third Class Cities of Pennsylvania, which represents all but three of the major municipalities of Pennsylvania.



Sewage Treatment Works of York Township, Ontario

CANADIAN INSTITUTE ON SEWAGE HOLDS SUCCESSFUL CONVENTION

THE Canadian Institute on Sewage and Sanitation held its 2nd Annual Convention in Toronto on October 17 and 18th, with an attendance of approximately 140 and official registration of 127.

The report of Secretary A. E. Berry, under whose leadership this two year old organization has made remarkable strides, indicated that a 50 per cent increase in membership gain had been made during the past year.

At the luncheon meeting on the second day, Toronto's sewage minded Mayor—James Simpson—and Ontario's practical minded Minister of Health—Dr. J. A. Faulkner—addressed the Institute. Thereafter an inspection trip was made to the recently enlarged treatment works serving the North Toronto District and the plant serving the Township of York, the latter being amongst the earliest plants to adopt mechanical sludge dewatering on drum type vacuum filters.

W. M. Veitch, City Engr., London, Ont., President of the Institute

A. E. Berry, Ch. Engr., Ontario Dept. of Health, Secretary-Treasurer

Officers Elected

Officers named for the ensuing year are:

President—Geo. H. Ferguson, Chief Engr., National Department of Health, Ottawa.

Vice-President—Grant R. Jack, Commissioner of Works, Township East York.

Sec'y.-Treas.—Dr. A. E. Berry, Chief Eng., Provincial Dept. Health, Toronto.

Trustees—H. S. Nicklin, City Engineer, Guelph, Ont.; N. J. Howard, Director of Water Purif., Toronto.

Technical Sessions

(President W. M. Veitch presiding.)

Amongst the papers presented that by A. E. Berry, which constituted a review of sewage disposal practice and operating difficulties with suggested means of overcoming such, was outstanding. It served as the opening gun in a symposium on operating difficulties, sludge disposal practice, and quality of effluents.

In the symposium, Mr. Chas. Chamberlain, superintendent of the York Township plant, dealt with sludge disposal by vacuum filtration and later with the ill effects on the activated sludge process charged to oily wastes reaching the plant. Mr. Wm. Storrie, Consulting Engineer of Toronto, discussed the use of sludges on land and the need for specific regulations now lacking, in governing such practices as health hazards. Mr. H. S. Nicklin, City Engineer of Guelph, related experiences in dewatering digested activated sludge and crude solids on sand beds.

Snapped at the Second Convention Canadian Institute on Sewage and Sanitation

Left to Right: (1) *J. F. McLaren, Cons. Engr., Toronto;* (2) *F. J. Leduc, Engr.-Alderman, Montreal;* (3) *A. Cousineau, City San. Eng., Montreal;* (4) *B. F. Lamson, City Engr., St. Catharines;* (5) *W. C. Miller, City Engr. and Treas., St. Thomas;* (6) *A. V. Delaporte, Chief Chemist, Ontario Dept. of Health;* (7) *N. C. Hobson, Canadian Ind. Ltd., Toronto;* (8) *W. B. Redfern, Cons. Engr., Toronto.*

Mr. Stanley Shupe, City Engineer of Kitchener, presented an illuminating discussion of operating difficulties at the Kitchener activated sludge plant which had been created by meat packing wastes and digester supernatant liquor. Resultant bulking of sludge had been corrected on several occasions by applying chlorinated lime to the aeration tanks and the returned sludge. Mr. W. B. Redfern, Consulting Engineer of Toronto, reported on the operation of the Mimico-New Toronto activated sludge plant, involving a combination of Imhoff tanks and supplementary separate digestion tanks equipped with the only floating cover in Canada.

Mr. N. J. Howard reported results of studies made at the North Toronto works to determine the effectiveness of the activated sludge process in eliminating bacteria and b. coli. The average b. coli content had been reduced by 99 per cent but still there were present averages of 1,483 per c.c. in winter and 4,187 in summer. Satisfying the effluent chlorine demand of 1.5 p.p.m. had reduced the coli count to 14 per c.c. resulting in a 99.99 per cent overall reduction.

Modern Chlorination Practices

In an illustrated talk, L. H. Enslow discussed "Modern Sewage Chlorination Practices" in which the established uses of chlorine, with especial reference to its adaptation as an adjunct in assisting present day methods of sewage treatment, were set forth. Particular attention was directed to the uses to which chlorination had been put in bettering condition and reducing operating difficulties and costs of treatment at activated sludge plants. Especially helpful had been the mild chlorination of returned sludge to control sludge bulking such as recently reported by the Lima, Ohio, authorities. (See October issue of WATER WORKS AND SEWERAGE.) Another important major development had been the benefits derived from thickening the wasted activated sludge in a separate tank before its transfer to the digesters. To render the scheme feasible, chlorine had been effectively used in moderate amounts to check the biological action during the holding period in the concentration tank. In odor control the application of chlorinated iron, produced by running chlorine water upwards through scrap iron and old tin cans in a pipe tower, was relatively new. It had the value of being more efficient and less costly than direct chlorination. In addition, the iron added had shown beneficial effects on the aerobic biological processes and likewise on sludge digestion. There was not the same need for careful control to avoid overdosage as was true with direct chlorination when employed ahead of the activated sludge process—a point considerably in its favor.

Round Table Conference

The forenoon session of the second day was given over to a lively and very helpful Round Table Conference on operation and maintenance "Kinks" and problems. Considerable interest developed in the possibilities of garbage disposal by grinding and discharge to sewers and the effect this method would have on the future of sewage treatment. Reports from Baltimore, Indianapolis, and Durham, N. C., had indicated the scheme to be a feasible one for disposal of portions of the garbage if not the whole of it.

R. C. Harris, Com. of Works, Toronto, and Past President of the Institute; H. S. Nicklin (Trustee), City Engr., Guelph; Wm. Storie, Consulting Engr., Toronto.

Chas. Chamberlain, Supt. Treatment Wks., York Township; Mr. Phelps, Sewerage Engr., Toronto; Stanley Shupe, City Engr., Kitchener

The use of chlorinated lime to correct septic sludge conditions in aeration units and sludge bulking had been found generally an effective emergency measure to be applied when needed to overcome the effects of oxygen deficiency in the system.

Root troubles in sewers had been successfully overcome by addition of copper-sulphate to manholes above affected sections of the sewers. There seemed to be no formula as to the dosage required as long as sufficient blue-stone was used—in small lateral lines about a double handful at each manhole had been enough. One member told of a copper ring which had been effectively used in pipe joints to stop roots from entering, by killing the tender ends.

For cleaning clogged air diffuser plates a variety of methods had been used. The generally favored method was the blowing of steam through the plates from beneath to "stew-out" the oil accumulations, aided by wire brushing to clean the upper surface. Some had used alkali or acid. Possibly the most certain and effective scheme of all was that of removing and burning the plates. It developed that The Corborundum Company had been rendering a plate renovating and re-burning service at a nominal charge.

There was considerable interest in reports that minor amounts of powdered activated carbon had been effective in improving sludge digestion and its subsequent drainability on sand beds. Especially interesting had this been to plants utilizing digester gas and those crowded with respect to digester and bed capacity.

NOTE.—Many of the papers presented and proceedings of the convention have already been printed in full in the two Canadian magazines, "Canadian Engineer" and "Engineering and Contract Record." The Canadian Institute on Sewage being affiliated with the Federation of Sewage Works Associations, most of the papers will also be printed in Sewage Works Journal.

[WATER WORKS AND SEWERAGE wishes to congratulate President Veitch, Secretary Berry and their Executive Board on the impressive progress made by the Canadian Institute and on the quality of its recent convention.—Editor.]

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BIDS ASKED FOR COLORADO RIVER AQUEDUCT PUMPING PLANTS—Bids will be opened Nov. 19 by Metropolitan Water District of Southern California on construction of two of the five pumping plants on main line of the Colorado River Aqueduct.

CHEMICAL TREATMENT OF SEWAGE EVALUATED IN A.P.H.A. COMMITTEE REPORT

PRESENTED BY LANGDON PEARSE, CHAIRMAN

A COMPREHENSIVE and exhaustive report on "Chemical Treatment of Sewage" by the Committee on Sewage Disposal of the American Public Health Association has been presented at the recently held annual meeting of the Association at Milwaukee, Wis.

The voluminous report of 207 typed pages, prepared by a group of leading chemists and engineers in the sewage treatment field under the direction of Langdon Pearse, Sanitary Engineer, Chicago Sanitary District, was presented by him as committee chairman. So far, the report is available in mimeographed form only and but a limited number of copies are available for distribution until exhausted.

In presenting a digest of the report, Mr. Pearse reviewed the possibilities and limitations of chemical treatment, saying that its chief promise lay in its adoption for seasonal usage when necessary to raise the efficiency of established processes, particularly sedimentation. As a continuous process the cost of chemicals for year round treatment rendered effective chemical treatment more costly than the biological processes and the tendency would be to curtail the chemicals applied to a point at which, if any at all were used, the results would be of questionable benefit. In England, preliminary chemical treatment continued to be utilized seasonally or continuously for reducing loadings on biological processes and the process had some merit in this adaptation.

The report directed attention to the proven value of chemical methods in the purification of industrial wastes and the decided progress made in this direction in Wisconsin on canning plant wastes at 45 plants. The sewage treatment plants listed as now employing chemical treatment were more extensive than commonly realized but those now employing, or to employ, the process as a seasonal measure make up all but a fraction of the total number. In the latter group were New York's Coney Island plant, Waukegan, Wis., Birmingham, Ala., Minneapolis-St. Paul, Minn., San Diego, Calif., Atlanta, Ga.

The report contains voluminous references to existing and expired patents covering chemical methods of treatment and carries a bibliography containing 240 references and ends with the following conclusions being set forth.

Conclusions

The chemical treatment of sewage includes a wide range of effort. From the data cited herein it would appear:

1. Chemical treatment usually accomplishes a degree of treatment between plain sedimentation and biological processes.
2. By the addition of a zeolite filter, following precipitation with generous amounts of chemical, the Guggenheim process substantially equaled an activated sludge effluent.
3. The seasonal or occasional use of chemicals is attracting favorable notice in situations where sedimentation alone may suffice for the greater part of the year or for many years out of a cycle.
4. The use of chemicals as a preparatory treatment, in addition to sedimentation, ahead of biological filters is in use in many situations and prolongs the useful life of existing plants, otherwise overloaded.
5. Of the various processes for chemical treatment of sewage considered in the United States the use of iron salts, particularly ferric chloride or ferric sulphate, seems most favorable.
6. The manufacture of iron salts from scrap iron or tin cans with chlorine has been favored in many situations for reasons of economy.
7. The use of iron salts, particularly ferric chloride, for sludge conditioning prior to vacuum filtration has been generally adopted where practicable.
8. The comparison of chemical treatment of sewage with other procedures should be studied carefully from the standpoint of adequacy, performance, and cost.
9. The use of chemical treatment in handling industrial wastes appears to have a definite place, where performance and cost justify the procedure as compared with other methods.

The Committee presents this report as a summary. If errors are found or additional data are available, the Committee would welcome the information at an early date, if sent to the Chairman,

Langdon Pearse, Chairman

A. E. Berry	C. E. Keefer
A. M. Buswell	F. W. Mohlman
C. K. Calvert	William Rudolfs
H. P. Eddy	P. J. A. Zeller

F. M. Veatch

Discussion

F. M. VEATCH, Consulting Engineer, Kansas City, Mo., in a brief paper which was presented by E. L. Filby, an associate, set forth experiences with chemical treatment seasonally applied at York, Neb., and Boulder, Colo. In one case the coagulant of chlorinated iron had been locally produced from tin cans, scrap iron and chlorine solution, passed upward through a tower. In the other, ferrous sulphate had been chlorinated to produce chlorinated-copperas. Interestingly, chemical treatment had been provided during the day flow only. While analytical results had been sparse and had shown lower efficiencies than anticipated, with the reasonable chemical dosages employed, and the effluent had not looked as attractive as desired, the effects of the treatment on the stream had been unmistakable even when a dilution factor of but 2 to 1 existed. Mr. Veatch advanced as a possible explanation, that the effect of even inefficient precipitation by the chlorinated iron salts had altered the rate or the mechanism of the oxygen demand cycle in the stream. In any event the seasonal nuisance had been eliminated at a reasonable expense even when a dilution factor of but 2 to 1 existed. Now, studies were being given mechanical filtration (straining) of the effluent to determine its added value and justification.

H. H. HENDON, Sanitary Engineer, Birmingham, Ala., in presenting operating data and costs during the past summer's operation of the Shades Valley Plant

(Birmingham) chemical plant, showed that the average B.O.D. of effluents had been 12 p.p.m. with suspended solids of 9.0 p.p.m. Dissolved oxygen had been 2.8 p.p.m. in the effluent during the treatment, representing a pick up through the plant. Soluble iron had been but 0.1 p.p.m. whereas the total (suspended) iron had been 1.7 p.p.m. The average chemical cost based on averages of 450 lbs. of copperas and 60 lbs. of chlorine per m.g. during the season had been $5.17 per m.g.—no lime being required. The iron content of the undigested sludge had been 8.5 per cent (dry basis) and volatil matter 45 per cent. Solids content of the chemical sludge pumped to the crude sewage, for additional clarification value and thickening in the primary clarifier with the coarse solids, had varied between 1.61 and 3.1 per cent. Experience had shown that not less than 90 minutes sedimentation period should be provided for effective chemical precipitation in the absence of subsequent filtration or straining. Concerning the effects of the chemical sludge on digester performance, Mr. Hendon reported that 1,500 p.p.m. suspended solids in the supernatant-liquor discharge had been reduced to 208 p.p.m. and the B.O.D. to 64 p.p.m., which seemed a remarkable achievement even with two stage digestion.

In respect to the value of series operation of the clarifiers (preliminary sedimentation ahead of the chemicals), he had not changed his opinion except to say that pre-settling alone had not continued to effect the reduction in chlorinated-copperas requirements which had been earlier observed. Series operation, however, had the distinct advantage of sludge return values in absorbing odors, in reduction of coagulant and thickening of the otherwise thin chemical sludge. Experiments on a plant scale had indicated that increasing the sludge held in recirculation offered no real advantage in quantities greater than 5 per cent by volume returned to the crude sewage. Attempts to carry larger amounts had resulted in sludge thinning and effluent deterioration due to oxygen deficiency, degradation of the sludge and diffusion of iron to the effluents. Since, at most points, series operation of settling units could be provided at little extra cost, the net benefits from 40 to 60 minute primary units justified that arrangement for plants seasonally employing chemical precipitation. At Birmingham they had not sought to carry on precipitation at its optimum pH value of 4.2 because of the added cost involved for maximum clarification efficiencies. They had stopped at a point where the efficiency vs. cost curve had prompted them to do—with the dosages fluctuating up and down within that zone.

L. F. Warrick, State Sanitary Engineer of Wisconsin, related some of the practical aspects of chemical precipitation of cannery wastes, the effluents from such treatment plants being acceptable in municipal sewer systems, direct to the stream, or for secondary treatment on sprinkling filters. Utilized ahead of sprinkling filters, odorless operation at remarkable overloadings had been the results observed. In general the use of iron salts and lime, and the fill and draw method of plant operation, had proved the most practical, effective and economical. Treatment control seemed far more certain with the fill and draw system, but two continuous flow plants were now being operated and their performance would be evaluated. In treating some wastes, notably that from Kraut production, alum and lime had been more effective than ferrous sulphate and lime. Mr. Warrick also directed attention to the Howard (chemical) process for precipitating organic matter and sulphur compounds from sulphite digester wastes produced in pulp production. A full scale plant was now under construction at a 100 ton capacity pulp mill and an overall reduction of 85 per cent in oxygen demand value of the waste was anticipated. (For a description of the Howard Process see Industrial and Engineering Chemistry for Oct. 1931.)

In the purification of wastes from dairy product plants and milk wastes in general, chemical methods had not proved sufficient nor practical because of the high solubility of the putrescible constituents. Sprinkling filter treatment had been the most successful and dependable of any method observed on milk wastes.

F. W. Mohlman called attention to the question of quality of sewages and its bearing on the efficacy and costs of chemical treatment. Recent experiences had indicated that changing quality of sewages was creating difficulties with chemical treatment just as it had with activated sludge.

L. H. Enslow pointed to some interesting but little understood effects of iron salts added to sewages ahead of secondary biological processes. Observations at Plainfield, N. J., and just recently at Atlanta, Ga., had revealed the fact that even though the ferric coagulant added in moderate dosages had produced no settleable precipitate, or visible improvement in appearance of the settled sewages, the sprinkling filters had been able to handle markedly increased loadings thereby. The iron and seemed to floc out in passage through the filters and did not tend to accumulate on the stones except on the surface where the brown color of oxidized iron was an indication. At Atlanta the experimental unit loaded at three times the rate of parallel filters had recently been shown to produce oxidation even greater than the normally loaded units. The effluent contained much small floc which was readily gathered together for settling out in the final humus tanks by use of a small secondary iron dosage.

It seemed that the more one investigates the matter the more evident it becomes that chemical treatment can be put on a sound basis as a distinctly valuable adjunct to sewage treatment in one or another way. To consider chemical precipitation as a practical method of treatment seasonally was sound reasoning and subject to little argument. Mr. Enslow said that it was this utilization of chemical treatment that he felt had the future it deserved. For the present the continuous use of coagulating chemicals, as an all season method of treatment to procure 75 per cent or better purification, was of doubtful practicability because of the continuing costs. However, against this must be compared seasonal operation costs spread over the year (per m.g. plant output) when weighing chemical treatment schemes for only seasonal use at plants designed for such. It was, on this basis that chemical treatment should be compared with more costly methods, both in respect to construction and maintenance, and more especially the annual operation costs, including periods when primary treatment is the only purification that can be justified on economic and practical grounds. It was this angle that appealed to the interest of engineers who were considering the economic as well as the technical side of sewage treatment.

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Sewage Treatment to Be Financed At Detroit by Raising Water Rates

The plan of amortization of a $11,000,000 federal loan for Detroit's $20,000,000 Sewage Treatment Works has been voted by the City Council. Amortization of loan and the plant operating expenses are to be met by adding to water bills about 2.4 cents for each 1,000 gals. consumed.

EXPERIENCES IN WATER MAIN CLEANING AT EVANSVILLE, IND.

By CHARLES STREITHOF

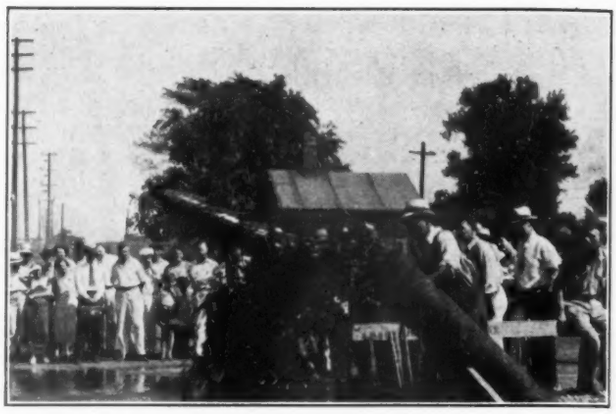
Genl. Supt., Dept. of Water Works, Evansville, Ind.

BEFORE the Indiana Section of the American Water Works Association, I had the honor and pleasure of presenting a paper entitled, "Inserting Gate Valves Under Pressure." (See WATER WORKS AND SEWERAGE—June 1934.)

The valves had been inserted in some of the important mains at Evansville and at the time I read the paper, I also showed some pictures. These pictures displayed sections of pipe, in sizes of 6 to 30 inch diameter, the sections being those removed from the various mains, to be replaced by valves. The true condition of the interior of the mains was shown, some of the sections being from 35 to 45 per cent filled with some kind of material. This proved to be hard blue mud. After the valve inserting job was completed, having seen the condition of our important mains, I felt justified in asking for an appropriation, to start cleaning some of the mains. I was able to convince our Board of Water Works Trustees of the necessity for, and the importance of, this work. It was decided to at least clean some of the larger and older mains; and, a contract was made with the National Water Main Cleaning Company of New York City, to do the cleaning.

The cleaning was started June 20th, 1934, on six thousand (6,000) feet of 16-inch pipe and was continued until the contract was completed. Under the contract a total of 37,956 feet of 12, 16 and 20-inch mains were cleaned, and practically restored to their original carrying capacities. The results obtained were so gratifying and satisfactory that the Water Works Trustees were thoroughly convinced of the advisability of continuing this excellent work. A second contract was made with the same company to clean all mains of 10 to 30-inch diameters which had been laid prior to filtration. The total length of mains cleaned under the second contract was approximately 87,500 feet, and the results obtained were as good as, if not better than, those of the first contract. The Board of Trustees then decided that it would be wise to clean all pipes laid prior to filtration. On November 1, 1934, a third contract was made with the same company, to cover approximately 450,000 ft., which included principally 6 and 8 inch pipe. Work on this last contract will be completed by November 1, 1935.

In the Foreground Is Ample Evidence That Evansville's Mains Needed Cleaning



Thar She Blows! The "Rabbit" Shooting Out of a 16-inch Main

Cleaning Procedure

The preparations and cleaning operations are simple, yet most effective. The section of line to be cleaned is "killed" by closing two valves, one nearest the inlet for the entrance of the cleaning apparatus, and the other nearest the outlet. At the inlet end, the pipe is exposed and a piece of the main, about 6 ft. long, is removed and cleaned by hand. The cleaning device (sometimes called the "rabbit") is placed in it, and the section is then returned permanently to the line by employing a sleeve or coupling and using the bell end of the existing pipe. At the outlet the line is also exposed, where a smaller piece is removed, depending on the diameter, so as to permit a 45 degree bend of the same size to be attached to the end of the line to be cleaned. This joint is made with yarn only. And to the 45 degree bend is added a short piece of pipe, jointed with yarn also, to bring the line up to, and a little above, the level of the street. Then the valves controlling the lines leading off from the one to be cleaned are closed. Likewise all curbcocks are closed. It is now time to start the cleaning apparatus on its journey. The valve nearest the inlet is opened. The water entering the dead line hits the cleaning machine and as the pressure and volume increase, the machine starts to move, and if there is no obstruction in the line, such as a partly closed valve or large pieces of lead from a poorly poured joint, the machine will travel the entire length of the line to be cleaned and come out on to the pavement at the 45 deg. outlet. The rate of travel is never alike in any two pipe lines of the same size and length. In cleaning 8,257 ft. of 30 in. pipe the cleaning machine traveled at a speed of 60 ft. per minute and discharged 47 truck loads of mud, not counting that which went into the sewers.

While the machine is moving, enough water is permitted to pass it to serve as wash water, which helps to reduce the pressure of the material ahead of the machine, and long before the appearance of the machine, some of the obstructing material will be seen on

the pavement. Almost from the moment that machine starts to move from the inlet end, until it is out of the main, the wash water which precedes it is very dirty. Immediately following the appearance of the machine at the outlet the water practically clears up, but it is advisable to permit the water to run a short time to thoroughly flush the line. When the machine has done its job, and the line has been flushed, it is a simple task to remove the makeup at the outlet, replace the piece of pipe there, open the valves which had "killed" the line and then those controlling the side lines, and finally the curbcocks.

Result of Cleaning

The results from main cleaning at Evansville were most gratifying. Velocity tests were run on various lines before cleaning, and the drop in pressure noted, as well as the discharge at the hydrants. The same hydrants were used after the mains were cleaned, and when the readings were taken, the difference showed an increase of 15 to 35 per cent in the water discharged. With two hydrants discharging 1,000 gallons per minute each, a drop of but two to four pounds was noted, whereas before cleaning a drop of six to fifteen pounds was common.

In addition, practically all the valves in the pipe lines were operated and tested, and those found defective were repaired or replaced. The customary annual inspection of valves is not necessary on the lines which have been cleaned, because of the very thorough job done in conjunction with the cleaning program.

Under the three contracts 506,129 ft. of pipe were cleaned as follows:

Diam.	Feet	Diam.	Feet	Diam.	Feet
30-in.	10,725	24-in.	2,196	20-in.	13,563
16-in.	30,238	12-in.	43,007	10-in.	4,609
8-in.	65,206	6-in.	324,350	4-in.	12,236

The cost was:

Contract cost	$55,700.52
Labor furnished by water department	27,881.22
Material furnished by water department	10,329.30
Repairing paved streets	5,330.41
Total cost	$99,241.45

The average cost was 19.6 cents per foot of pipe (all sizes) cleaned.

Average material cost was 3 cents per 100 ft., which included paving, pipe, lead and yarn, repairing old valves and new valves where necessary.

During the pipe cleaning, the question was often asked: "How did all the mud get in the pipes?" The answer is this: The first water works was built in 1873 and took the supply direct from the Ohio River and pumped it into the pipe system without any settling or filtering.

A Section of 16-inch Main Removed to Insert Cleaning Machine

Section of 20-inch Main During Cleaning at a Busy Corner

In 1912 when the present filter plant was placed in operation, every effort was made to flush the mud out of the pipe lines but without success. On account of lack of funds the pipe cleaning job was delayed until June 1934.

The question has been asked: "How did you pay for the pipe cleaning job?" The answer is this: The Water Department has always made a nice profit but in order that our books will show no loss when making such a large expenditure at one time, a "Deferred Charge" scheme has been instituted in order to spread the costs over a period of 10 years. However, understand, the Water Department payed all of the bills in cash—the "Deferred Charge" being only a matter of bookkeeping to spread the cost out.

The people of Evansville have been most interested in and enthusiastic about the main cleaning program. They consider the money well spent for they realize that in addition to restoring the system to its original carrying capacity, which assures them increased pressures and volumes, an ever present and dangerous fire hazard has been removed.

Acknowledgment.—The above article has been taken from a paper presented before the Southwest Section of A. W. W. A. at Houston, Tex.

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Representative Water Rates

That where water is the dearest it has been made available at such comparative low cost to consumers is a situation stressed in its publicity releases to consumers by Los Angeles' Department of Water and Power.

What the Official Bulletin "Water and Power" has to say to Los Angeles Water takers is of interest.

"Water and Power" has the following to say:

"Los Angeles consumers pay the low rate of 13 cents for 100 cu. ft. (750 gallons) of pure water brought in from mountain streams 250 miles distant. For the same amount of water the average charge in 183 of the larger cities in the United States is 18 cents."

The following rates charged by representative cities are cited in comparison:

San Francisco	28 cents	Youngstown, O.	20 cents
Pittsburgh, Pa.	25 cents	Miami, Fla.	19 cents
Indianapolis, Ind.	22 cents	Boston, Mass.	15.4 cents
Des Moines, Ia.	22 cents	St. Louis, Mo.	15 cents
		Los Angeles	13 cents

Any municipality which can show a rate below the 18 cents per 100 cu. ft. average in 183 representative American municipalities would do well to utilize the figures quoted below, release the "story" to the local press and distribute reprints of this "news" with its water bills.

HANDLING EMERGENCY MAIN REPAIRS

By HENRY E. NUNN

Superintendent of Water Works,
Van Buren, Arkansas

Henry E. Nunn

METHODS for handling emergency repairing may vary greatly according to local conditions and so often will depend on good judgment of the man in charge, that it would be presumption for me to attempt to outline any set rules for guidance. Rather, it seems more to the point to discuss: preparations, crew organization, adequacy and care of equipment, and maintenance. These things have a very vital bearing on "Methods For Handling Emergency Main Repairs," whatever those methods may be.

A famous general once said, "The best way to win a battle is to get there firstest with the mostest men." A good way to attack an emergency repair is to get there promptly with plenty of men. Incidentally, the men must know what to do and have equipment with which to do it. As most water works managers already know, three things are very helpful in emergency work: getting on the job promptly, competent men, and equipment in good condition.

Getting on the job promptly depends on crew organization. This is not a difficult matter during regular hours, nor is it difficult for larger plants that may have an adequate night crew. But, for smaller plants it is important to have, at least a skeleton crew where it may be reached quickly at any time after regular hours. One foreman should at all times be within telephone call and he should know where to locate members of his regular crew.

Efficiency will depend in a large measure on accurate and dependable records. Mains, valves, and hydrants should be mapped accurately and the foreman should be able to read the map and should become familiar with the system, so that in case of trouble he will know where to go, which valves to cut off, and what section of the system will be affected by the break. This is likewise of importance to the fire department and also to interested consumers.

False Tool Economy Costly

Men should have the tools they need. Paying two men to use the same tool proves to be poor economy when each may have one which can be paid for with money saved in a few hours' work. Even though the supply of equipment may be limited. it can be kept in good condition and where it may be found. The emergency crew should have a place for tools where they may be found and it should be held responsible for their condition and availability. It is embarrassing as well as costly to have a break and find: your picks and drills dull, your hoist at the plant, the ditch pump in some councilman's cellar, and other tools scattered here and there. After each job, time is saved by looking over all equipment used to see that it is in condition to go on the next job.

A job should be completed in a thorough manner. Throwing something together in a slipshod way may cause more grief on the second trip than was found on the first.

Upon arriving at a break, the work usually depends on local conditions and good judgment. However, it is always well to have room in which to work. Besides having good tools, room is needed to use them. It is wise to dig a trench big enough in the beginning; so that it will not be necessary to dig it out more when the job is almost finished and after much time has been wasted working in cramped quarters. Ample provision should be made to take care of leakage and seepage. A crew cannot make much headway with water all over the pipe. It will probably have to be bailed or pumped out anyway so time will be saved by digging a sump and being prepared to handle the water from the beginning. Sometimes with a little digging the trench may be drained into a storm sewer, provided the foreman is familiar with the storm sewer system.

In repair work care and good workmanship is no less important than was the case when the pipe was laid originally. There is just less time in which to do the work. Sometimes an investigation will uncover the cause of the trouble, giving one a chance to correct it and avoid the same trouble in the future. For instance, if there is a high rock in the trench near the break, it should be removed—solid rock should be excavated well below the grade line—and the trench brought up to grade with well packed earth, to avoid settlement.

In working with broken pipe where there is no bead, it is possible to loosen the broken pieces and pull them out. Then, by working a joint or two loose in each direction, a full joint of pipe may be buckled into place to replace the two pieces. In some cases this may prove more practical than using a sleeve. The labor will be increased but the cost of a sleeve and a joint is saved. A little more excavation and a little more caulking will be required.

Consider the Consumer

Another item of importance, sometimes neglected, is proper consideration of consumers when it is necessary to shut off a line for repairs. They should be notified as soon as possible and given some idea of the period of time they will be out of water. Immediately on arriving at a break, it is worth while to send a man to notify all who will be affected, in order that they may prepare themselves, by filling tubs, etc., with water, cutting off boilers and heaters, or taking any other precautions they may desire to lessen their inconvenience. This pays dividends in "good-will" and encourages citizens to remember the department when they see any trouble and to report it. Parkings and driveways should be littered up as little as possible and considerately and thoroughly cleaned up after the work is finished. In replacing pavement the use of quick setting cement is worth the added expense.

Work should be well protected by barricades and lights. Aside from the question of liability for accidents, more efficient work is done if the workmen do not have to worry about passing vehicles getting too near. Good lighting makes for quicker work and a better job.

The Fire Department should be notified which mains

and hydrants are out of service and which streets are blocked. The Fire Chief will appreciate being notified again when the repair is finished. A check up should be made to be sure that all valves have been opened after the line is back in service. Good judgment should be used in turning the water back into the line.

Better Maintenance, Less Repairs

A mighty good way to simplify the problem of emergency repairs is through efficient maintenance. Sound maintenance will lessen the number of emergency calls. If a leak is fixed in time, it not only saves water but may save a call in unpleasant weather and at an inconvenient time. It is well to inspect dirt streets in late summer or early fall and to find out how much pipe the street crews have left insufficiently covered in time to get it lowered before freezing weather. Although the pipe was laid deep originally, grading and erosion may have left it too near the street surface. Valves should be kept in condition. It is good practice to inspect all valves each year and have a man close and open each valve in the system.

In summarizing, important items in meeting emergency repairs are: Have an organization that is able to function promptly and efficiently at all times; have up to date and accurate records of the system; know the system and keep workmen who do; and, last but not least, keep up maintenance.

Acknowledgment.—The above paper was presented before the Southwest Section of A. W. W. A. at Houston, Tex.

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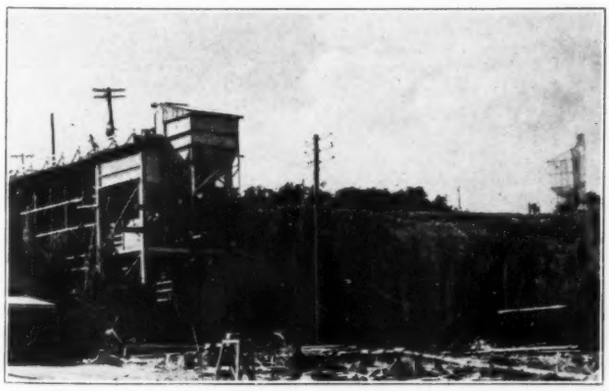
Unique Concrete Handling at Milwaukee Plant

Utilization of cement and aggregate storage bins and batchers in a unique arrangement has resulted in a substantial saving in the cost of Milwaukee's 200 M.G.D. filtration plant now under construction.

The plant is being built out into Lake Michigan by means of a coffer dam. Its location is several miles from a railroad, which could be reached only by trucks traveling through a residential section of the city. Because of that, special adaptations of machinery for handling bulk cement and aggregates had to be made.

The location of the plant at the base of the steep lake bluff enabled construction of a ramp from the top of the bluff directly to the bins of the central mixing plant. (See picture.) Trucks backed onto the horizontal ramp unloaded by gravity directly into hopper. Crane operating costs of from $65 to $75 a day were eliminated by the side-hill construction. Because all material had to be hauled to the site by motor truck, there was a decided saving in locating the plant under the hill, as unloading operations did not require an extra handling of materials.



Central Concrete Mixing Plant and Storage Bins for Materials, Milwaukee Filtration Plant. Note the 450-*Bbl. Storage Bin on Right Which Was Built to Eliminate Night Hauling by Truck. In Foreground—Concrete Pipe Line* 1,500 *Ft. Long.*

There was no handling of either aggregates or cement at the site. Concrete was pumped 300 to 1,500 feet from the central mixing plant to the forms, by pipeline, employing the method of construction developed at Boulder Dam, Wilson Dam and other construction projects. With pouring operations rushed day and night the trucks were hauling cement and aggregate continuously. Residents complained of the noise of trucks at night, and the Milwaukee city council required contractors to erect a storage bin to hold sufficient materials to enable operation at night without the necessity of hauling by truck. A 450 bbl. bulk cement storage bin was erected near the central mixing plant (see picture) to comply with the city order. This bin, loaded by day, was available at night when materials ran low at the proportioning plant. The aggregate storage bin had three compartments, one for sand and the other two for different sizes of gravel.

The job is a PWA project on which L. R. Howson (Chicago) is Consulting Engineer and Kramp Construction Company (Milwaukee) the contractors. The bins and mixing plant were manufactured by the Butler Bin Company of Waukesha, Wis.

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Association Meetings Scheduled:

Nov. 4—**North Carolina Section A. W. W. A.,** Durham, N. C. M. F. Trice, State Board of Health, Raleigh, N. C.

Nov. 4-6—**Wisconsin Section A. W. W. A.,** Sheboygan, Wisconsin. Annual Convention. Sec'y., L. A. Smith, City Hall, Madison, Wis.

Nov. 7-8—**Virginia Section A. W. W. A.** Hotel Roanoke, Roanoke, Va. Sec'y., H. W. Snidow, State Department of Health, Richmond, Va.

Nov. 6-8—**Missouri Valley Section A. W. W. A.** Fort Des Moines, Iowa.

Nov. 6-8—**Missouri Valley Section A. W. W. A.** Fort Des Moines, Iowa. Sec'y.-Treas., Earl L. Waterman, Prof. Sanitary Engineering, University of Iowa, Iowa City, Iowa.

March 23-25, 1936—**Kentucky-Tennessee Section.** Lexington, Ky. Sec'y. F. C. Dugan, State Board of Health, 532 W. Main Street, Louisville, Ky.

April 7-9, 1936—**Indiana Section A. W. W. A.** Purdue University, Lafayette, Ind. Sec'y.-Treas., John A. Bruhn, Indianapolis Water Co., Indianapolis, Indiana.

June 8-12, 1936—**American Water Works Association.** Annual Convention. Biltmore Hotel, Los Angeles, California. Sec'y., B. C. Little, 29 West 39th St., New York City.

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Oklahoma City to Charge Packing Industry for Treatment of Its Wastes

An ordinance has been recently passed by the Oklahoma City Council which levies a charge against industry for treating its wastes at the municipal sewage treatment works. The charges to be assessed against the meat packing plants in Oklahoma City will be approximately $12,000 per year. This represents a fair portion of the cost to which the city will be put in giving complete treatment to the combined domestic sewage and trade wastes discharged by the packing plants.

When the 5 year contract provided by the ordinance is signed a 10 year dispute between the City and the meat packers, concerning the disposal of their wastes and the expense to the City created by such wastes entering its sewer system will have been settled. The City estimates that the packing wastes will add an additional $18,000 per year to the cost of sewage treatment when additions to the Southside Treatment Works are completed.

PUTTING SEWAGE EFFLUENT TO WORK

by CHARLES C. AGAR*

Albany, N. Y.

AN adequate supply of water under pressure is considered essential for the proper care of the modern sewage treatment plant. It not only reduces the manual labor and time necessary at the plant, but also provides an effective agent in improving the operation of various units. Washing the screen chamber, removing solids from inlet channels, cleaning tank walls, breaking up solids in gas vents of Imhoff tanks, flushing sludge lines and even watering the lawn and shrubs illustrate some of the many practical uses for which a water supply can be used to advantage.

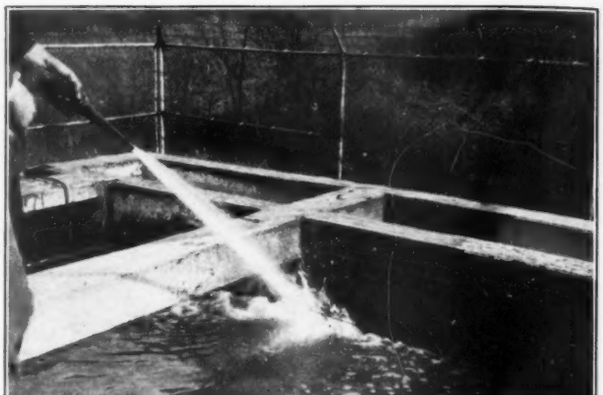
A source of water is always necessary during the construction of the plant and frequently such supply is developed as a permanent installation. After a plant is completed and in operation for a time, however, the usual methods of obtaining a supply (such as from a water main extension, well, or nearby stream) presupposes the practicability of such methods and the provision of the necessary funds to carry out the work. When Frank Ryan, Superintendent of Sewers, took charge of the Delmar, N. Y., sewer system two years ago there was no water supply available at the treatment plant. After considerable investigation he adopted a somewhat novel source and method of providing a water supply which involved the use of the sewage effluent from the plant itself.

The Delmar plant, serving a population of about 2,500, consists in general of a housed screen chamber, Imhoff tanks and open sludge drying beds. The plant is well isolated in a ravine about one-half mile from the Normanskill Creek, a tributary of the Hudson River and into which the plant effluent discharges. Without a water supply, the proper care and operation of the plant was an arduous task. Influent channels required frequent agitation to remove deposited solids, skimming of the sedimentation compartments and scraping the walls was a tedious process and the gas vents required considerable manual work to prevent an excessive accumulation of scum.

The use of the municipal water system would have required one-half mile of water line. Experience indicated that the development of an adequate well supply at the plant site was uncertain and there was no dependable surface watercourse available in the vicinity. The financial condition of the sewer district precluded the extension of the water system at the time so the superintendent finally obtained a small portable pumping unit.

*Senior Sanitary Engineer, New York State Dept. of Health.

Midget Portable Pump at the Delmar (N.Y.) Sewage Plant Does Giant Duty. Pumps Sewage Effluent, Used for Flushing.



A Flushing Stream of Sewage Effluent That Does the Job at Little Expense.

Portable Pump Installation

As installed in the screen house near the tanks, the water supply system consists of a two inch self-priming Jaeger centrifugal pump directly connected to a one cylinder 4 H.P. gasoline engine. It is a type commonly used by contractors and is of rugged and durable construction. A suction line extends into the outlet end of the sedimentation compartment of the tank and the discharge line extends outside the building where may be connected the hose line. The pump has a rated capacity of 150 gallons per minute and when using a ¾ inch nozzle develops a pressure of 35 to 40 pounds, which is more than ample for all normal plant uses.

The entire cost of the installation including fittings and hose line was less than $200. During two years of frequent use the pump has proven dependable and has greatly reduced the manual labor formerly required to maintain the plant in effective operating condition.

This serves to illustrate how the wide awake operator can use his ingenuity and make the most of limited funds in obtaining an improvement which not only conserves time and labor but also greatly aids the operation of the treatment plant.

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PWA Projects

In a recent release the following has been taken from a breakdown of projects approved by PWA and grants allowed:

Type	Projects	Grant
Sewerage (total)	366	$54,899,058
Sewage disposal plants	167	34,778,999
Sanitary sewers	157	11,118,280
Storm sewers	30	1,812,637
Combined sewers	12	7,189,142
Water systems (Total)	529	$30,098,535
Water mains	41	2,482,347
Filtration plants	20	2,158,543
Reservoirs	33	3,633,156
Complete waterworks	435	21,824,489
Water and sewerage (total)	35	$ 1,742,211

IMPROVED STANDARDS FOR THE RESIDUAL CHLORINE TESTS

NEW Standards Which Are Permanent and Subject to Less Exact Usage

By R. D. SCOTT*
Columbus, Ohio

IN DETERMINING residual chlorine with ortho-tolidine by comparison with the Ellms and Hauser permanent standards, of Standard Methods of Water Analysis,[1] it has been generally observed by Chromas[2] and others that the color intensities and hues of the standards as viewed through the tube length give values in residual chlorine differing from those obtained when viewed through tube walls, as is practiced in making pH determinations.

Through the tube wall a standard which has matched the color of a sample, with exactness, will appear weaker in color than the sample and possess a yellow hue, in general poorer in green than the sample.

Although the current edition of Standard Methods does not specify the manner of comparison, it is generally understood that it should be done by looking through the length of the liquid columns if proper chlorine values are to be recorded. It may be mentioned here that the next edition will warn against making comparisons in any other than this empirical manner which was that followed in compounding the existing standards from the standard dichromate and copper sulphate solutions.

Among the published observations on the difference in color readings is that of Donahue and Zimbon[3] who directed attention to the appreciable errors which would result if an attempt was made to use the standards compounded according to the A. P. H. A. Standard Methods in square bottles (32. ml. width), for matching sample and standards when viewed from the side. To overcome the error, they recommend different proportions of dichromate and copper-sulphate solutions. For example, their 0.06 P.P.M. Cl. standard contains 7.0 cc. of 1.5 per cent copper-sulphate and 8. cc. of 0.025 per cent potassium-dichromate solution in 100. cc., whereas Standard Methods calls for 0.8 cc. copper-sulphate and 6.6 cc. potassium-dichromate solutions of the above strengths.

Standards prepared in accordance with their recommendations were observed to match colors developed in standard chlorine solutions reasonably well as to intensities, but not as to hues. The proportion of green to yellow is somewhat greater in their standards than in actual samples.

The Need of More Flexible Standards Felt

It has long seemed desirable to the writer to have permanent standards available which would closely match the Cl.-O.T. colors, both as to intensity and shade of color (hue), in order that color comparisons might be made with more accuracy and also that the tube length need not be limited to 300. mm. and, therefore, the controlling factor that it is in making accurate tests.

Work was accordingly started with the idea of developing a less empirical test. Many combinations of dichromate and copper sulphate, and also of dichromate and nickel sulphate, solutions were tried without success. It was not found possible to maintain the proper proportion of green to yellow over the range 0.01 to 1.0 p.p.m. of chlorine. Mixtures of *chromate* and *di*-chromate were then prepared, with encouraging results. A dilute potassium *chromate* solution in itself has a green-yellow hue, but exhibits more green than a Cl.-O.T. solution. However, by adding the proper proportion of potassium *di*chromate solution, which is yellow or red-yellow in dilute solution, it is possible to match the color of the ortho-tolidine treated chlorinated water.

After trying various proportions it was found that graded amounts of a solution containing three parts of potassium *chromate* to each part of potassium *di*chromate produced a solution, the color of which apparently exactly matches that of Cl. + O.A., both as to hue and intensity. Further, the matching is exact regardless of whether viewed through length or breadth of the tubes, and includes the broad range of 0.01 to 3.0 p.p.m. chlorine. The proportion of green to yellow, apparent to be identical for standards and samples.

It was further noted, that these standards must be held within a rather narrowly limited pH range, because *chromate* solutions deepen in color in the presence of acid and *di*chromate solutions lighten in color in the presence of alkali. The explanation is the formation of *di*chromate in the acid medium and chromate in the alkaline zone. In order that the standards be assured of remaining constant, it has been found necessary to maintain them in a pH zone of 6.3 to 6.7. This is readily effected by using a buffer solution in their preparation.

Procedure of Standards Preparation

Solutions: (1) 0.25 gram potassium dichromate ($K_2Cr_2O_7$), and 0.75 gram potassium chromate (K_2CrO_4), in 1 liter of distilled water.

TABLE 1—FORMULA FOR STANDARDS

Chlorine Values (P. P. M.)	Chromate-Dichromate (C. C.)	Volume of Buffer Solution (pH. 6.5)
.01	0.3	Sufficient to dilute color solution to 100 c.c.
.02	0.7	
.03	1.1	
.05	1.9	
.07	2.8	
.10	4.4	
.15	7.4	
.20	10.0	
.25	13.0	
.30	16.0	
.40	2.1*	
.50	2.6	
.70	3.6	
1.00	5.2	
1.50	8.0	
2.0	11.2	
3.0	18.0	

*Below the line a solution containing 0.25 grams $K_2Cr_2O_7$ and 0.75 gram K_2CrO_4 in 100. c.c. is employed.

*Chief Chemist, Ohio State Dept. of Health, Columbus, O.

(2) Buffer solution (pH 6.5), is prepared from 13.616 gms. of potassium acid-phosphate (KH_2PO_4), and 30.2 cc. normal sodium-hydroxide solution made up to 2 liters with distilled water.[4]

Quantities of the above chromate-dichromate solution, indicated in Table I, are pipetted into 100 cc. Nessler tubes of any uniform length. Thereafter the buffer solution (pH 6.5) is added to the 100 cc. mark. The standards may be used in standard Nessler tubes or in bottles of uniform quality and dimensions as may be desired.

Beyond 3.5 to 4.0 P.P.M. Cl-ortho-tolidine colors become erratic in hue and subject to rapid change in intensity. Concentrations of chlorine beyond 3.5 p.p.m. do not appear to be susceptible to accurate determination with O.T. unless previously diluted with water the chlorine demand of which has been satisfied as prescribed below.

The series of chlorine concentrations used in adjusting the standards were prepared from a calcium hypochlorite solution containing between 20 and 25 p.p.m. chlorine, as determined closely by iodometric titrations twice daily. From this stock solution dilutions were prepared, as needed, using distilled water previously treated with 1 p.p.m. Cl, then boiled until free from chlorine and cooled.

The standards prepared as described have stood as long as six weeks in direct sunlight, without fading.

Acknowledgment.—The above contribution was presented before the 15th Ohio Annual Conference on Water Purification at Cleveland, Ohio.

REFERENCES

[1]Journal of Industrial & Engineering Chemistry—5, 915, 1913.
[2]U. S. Bureau of Standards, Tech. Paper No. 167, 1920.
[3]Water Works and Sewerage, 82, 228, 1935.
[4]"The Determination of Hydrogen Ions" (text)—Clark.

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The "Newestest" Use for Digestion Gas

An old custom meshes in with the march of progress at Lexington, Ky. Improvements in 1934 to the Imhoff trickling filter sewage treatment plant of the City, provided heated separate sludge digestion tanks, the gas from which is utilized to heat buildings, including residence of the veteran caretaker, Chat Pollock. The gas fuel conveniences were recently extended to the old wash pot in Chat's back yard. Here we see Chat's wife, Evelyn, at the weekly task of boiling the family wash while her boy, June, the girl, Evalucy, are interested spectators. Only a small loop of perforated pipe under the pot with a half inch valve and short length of pipe were required to modernize the family laundry.

"Modernizing" the Family Laundry

Mr. R. J. Austin, a University of Kentucky graduate, is Superintendent of the renovated sewage treatment plant at Lexington. To Wellington Donaldson of Fuller & McClintock, Engrs., we are indebted for the snapshot used.

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Obnoxious Gases Deodorized with Chlorine

Waste gases containing sulphur compounds have probably caused more complaints from neighbors of chemical works than any other gaseous compounds because of their highly offensive odor, even in great dilutions. Various methods have been used by manufacturers to eliminate this nuisance including removal of hydrogen sulphide by washing the waste gas or running the entire gas through the boiler furnaces. All these methods were, however, either not quite efficient or they interfered with the manufacturing processes.

German viscose factories have adopted a new method recently which is said to be completely satisfactory. Waste gases are deodorized by introducing small amounts of chlorine. This procedure has only become fully effective through efficient control of the flow of chlorine according to the volume and composition of the waste gas.

The amount of chlorine requisite to effect deodorization was found to be only one-eighth of the theoretical amount necessary to oxidize the hydrogen sulphide. The explanation advanced for this surprising result is that this gas produces a selective oxidation of the organic sulphur compounds present in minute quantities in the waste gases and oxides those which are particularly offensive and responsible for the specific "viscose plant smell" to a greater extent than is hydrogen sulphide itself.—*German Chemical Notes.*

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Pittsburgh Starts Important Action, Seeking Abatement of Water Pollution

On October 21st, Mayor Wm. N. McNair and Council of Pittsburgh, Pa., passed what may prove to be a resolution of far-reaching importance in the history of municipal action against stream pollution.

Resolution No. 225 of the City of Pittsburgh constitutes an initial step towards securing a concerted effort on the part of neighboring municipalities to obtain the abatement of stream pollution. State officials are therein called upon to enforce regulations which will reduce pollution entering the Alleghany River and tributaries—the sources of water supply for Pittsburgh and many other neighbor communities. The Mayor's office has mailed out to affected municipalities and water companies copies of Resolution No. 225 with a letter suggesting concerted action.

The bill of complaint lists known industrial plants and coal mines responsible for the pollution. It outlines the effect on the public water supply, states the added cost of treatment necessitated thereby and lists public water supplies thus affected. The resolution then calls on the Attorney General of Pennsylvania, the State Department of Health and the State Sanitary Water Board "to take such steps as are necessary to provide prompt, reasonable and continuous relief to affected communities lying along the Alleghany River and its tributaries."

EDITORIAL

Needed—More Publicity

OPERATORS of water works and sewerage systems are as a rule notoriously reluctant when it comes to availing themselves of opportunities of securing local publicity. That this should not be the case has been emphasized by Frank A. Barbour, president of the American Water Works Association, in his recent addresses before meetings of the several state sections of the association.

It is all too frequent that what publicity the water utility is accorded by the local press is of the fault finding variety which comes about as the result of a main break, bad tastes and odors in the water, frozen hyrants or other temporary failures or accidents from natural causes. Water works managers are very reticent when it comes to answering criticisms or attacks on the utility through the medium of published replies to such articles and editorials in order that false impressions may be corrected.

Do water works managers fear the possibility that such a reply may be construed as an alibi rather than an explanation? Or, do they refrain from according serious attention to some half-baked reporter's story or editor's blast enlarged or distorted to suit his idea of what will most attract attention or make popular reading? Whatever the reason may be, it is far too infrequent that citizens are properly and accurately informed through the local newspapers when accidents occur in connection with a public utility and its operation and true worth to the community are taken too much for granted. Usually the personnel of the water works are too busy correcting conditions or improving the technical features of water supply to be concerned with the psychological aspects of the situation. It is a fact that the sincere operator doing a good job usually under estimates the value which effectively molded and directed publicity possesses. Likewise, he overlooks the cumulative hurt of the hammer swinging type of destructive publicity—and, this regardless of its political aspects.

Operators of municipally owned systems seem to be especially apt to overlook or lose sight of the full significance and value of favorable publicity to the utility and particularly to the employes of the service department. The reason for this appears to be largely a matter of personal modesty on the part of the superintendent. He dislikes giving out stories for local publication which might be construed as "horn-tooting" by his neighbors or other municipal department heads. Especially is such publicity shyness noticeable in the smaller communities in which the superintendent of water works is as well known as the mayor. The truth is that he under estimates his value to the community.

Mr. Barbour strikes a keynote when he states that more publicity in connection with that most essential of the public utilities—the water works—is sorely needed. Further, it is absolutely necessary if water works operators, as a whole, are ever to be accorded. by the general public, the credit which is justly due them and the profession. And, even more to the point, if responsible and efficient operators are to become secure in their position and effectually appreciated and compensated in return for the services performed, the water department must seek, through education and popular appeal, the creation of an ever increasing number of friends and boosters from the *voting* population as well as from the consumers.

President Barbour has suggested that all members of the A. W. W. A. should be assisted in attaining such an end by being supplied with effective publicity "copy" which can be turned over to the local newspapers at desired intervals. Such brief articles could be used without alteration or could be utilized as patterns in developing items specifically written to fit local conditions. As to the development of publicity calculated to raise the status of the local water works personnel, it was Mr. Barbour's recommendation that the state sections of A. W. W. A. and the parent association establish special "Committees on Publicity." One specific duty of such committee should be that of seeing that effective news items concerning its members taking an active part in the association management or functions and those presenting papers at meetings be gotten back to that member's home town newspapers. Where possible the use of photographs to accompany such news items and digests of papers should assist materially in developing the type of publicity which the association may secure in the interest of its individual members and the ultimate benefit to the entire local water department personnel.

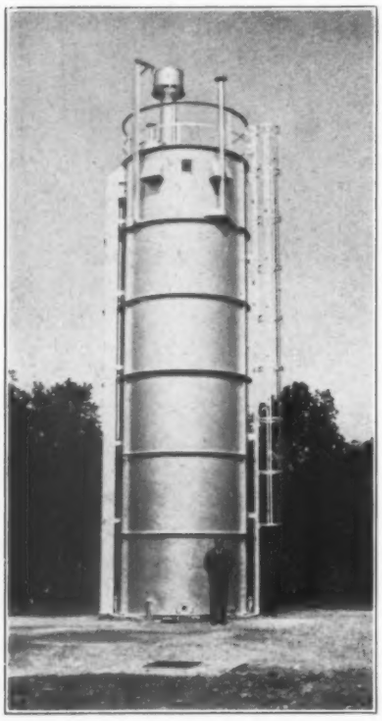
In this connection it has been observed that as a rule the stronger the local publicity accorded water departments the more secure has been the position of the manager or superintendent and the better appreciated is his entire staff. What water works operators now need as much as anything else is a good press agent. If the American Water Works Association and its many state sections, individually, can serve its members as "press agent" and as a propaganda clearing and distribution agency, membership therein should prove more inviting than it ever has been in the past. Such a movement is much needed and with increased membership in the association its publicity efforts can be strengthened and broadened materially as the result of increased appropriations.

Every individual state section can materially serve its present members and attract new members by adopting the committee type of "press agent" service for the municipal employe who deserves it most—the water works operator. It is a worthy innovation and one which assuredly promises returns of a most tangible nature to the A. W. W. A., to its individual members and, in turn, to the entire profession. WATER WORKS AND SEWERAGE wishes to take this opportunity of endorsing and lending any support possible to the program advocated by President Barbour.

NEW EQUIPMENT AND LITERATURE

New Type Gas Holder

Recently introduced in the sewage treatment field is the modern Stacey-Klonne Dry Seal Gas Holder manufactured by Stacey Brothers Gas Construction Company of Cincinnati, Ohio.



Stacey-Klonne Gas Holder

These novel waterless holders make use of a unique lubricated *mechanical* seal which travels up and down with the floating dome within the cylindrical walls of the holder. No liquid seal is involved and thus maintenance of liquid levels and unsightly appearance of the floating cover are avoided. The gas dome travels as a piston within the holder shell, gas leakage being prevented by a flexible and adjustable packing seal, located contiguous with but just above the dome and therefore always accessible.

Aside from its low cost of upkeep and less ground space required, the manufacturers cite, amongst others, the following advantages: lower foundation costs; desired high or low pressures constantly maintained; no liquid seal troubles, including corrosion and freezing; less supervision and painting; attractive appearance.

Worth asking for are Stacey Brothers Bulletins Nos. 35 and 40, which effectively illustrate and describe the mechanical details and advantages of Stacey-Klonne Dry Seal Gas Holders and also other types of Stacey gas holders. Address Stacey Brothers Gas Construction Company, Cincinnati, Ohio—also, 24 State Street, New York City.

New Morris Pump

An improved non-clogging pump for handling sewage or pulpy materials at high speeds and against high heads, has been developed by Morris Machine Works, pioneer American manufacturers of centrifugal pumps. The feature of the new design is that it permits the use of standard high-speed motors which are more compact and less expensive than the lower speed motors required for older types of non-clog pumps.

New Morris Pump

The unit is completely self-contained, with heavy duty double radial and thrust bearings supported on a substantial extension of the hub-disc, so that both bearings are maintained in perfect alignment with the pump body. A special advantage of this construction is that when installing the pump the bearings will not require lining up or adjusting. An exclusive feature is the floating suction ring which is designed so that solid particles will not interfere with its effectiveness as a seal between the suction and pressure parts of the pump.

Efficiencies above 85 per cent have been attained in several installations of these new units which are built, both vertical and horizontal, in sizes from 3 to 10 in. and with open or enclosed impellers. For further information and descriptive literature, address Morris Machine Works, Baldwinsville, New York.

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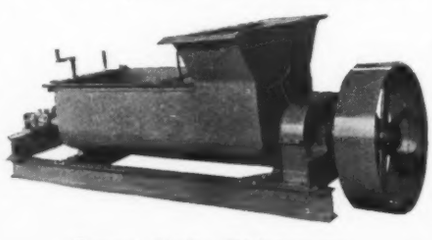
Bonnot Sludge Disintegrator

The Bonnot Company of Canton, Ohio, is offering a new type of Sludge Disintegrator and Mixer. This unit, with a slight change in adjustment, can be converted from a disintegrator to a mixer. Operating as a disintegrator, it will break down 6 to 8 inch lumps of sludge (containing up to 40 per cent moisture) into a product readily handled as a fertilizer or fertilizer base. During this process chemicals may be added, if desired, and the unit simultaneously disintegrates and uniformly blends the fortifying materials with the sludge. A novel adjustment device controls the rate of material fed through and the work done thereon to obtain practically any desired result within the range of the disintegrator.



Bonnot Sludge Disintegrator

The unit is constructed ruggedly and thoroughly braced. The hopper and main body is of heavy welded steel construction, and gears of steel, with machine-cut teeth, are completely enclosed. A flat belt, V-belt or gear motor can be used in driving the disintegrator.

The Bonnot Company have been producers of pulverizing and grinding equipment in the industrial field for many years and the new disintegrator has been under development and test for some time.

For descriptive literature and further information address the Bonnot Company (Crushing and Pulverizing Division), Canton, Ohio.

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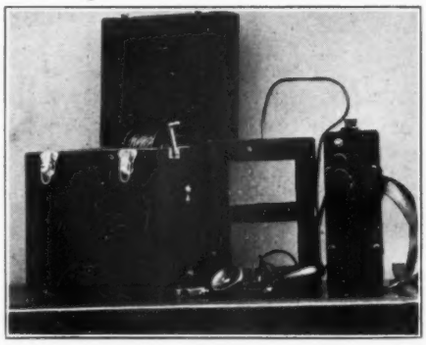
A Radio Pipe Finder

The Globe Phone Manufacturing Corporation has recently developed a new type of pipe locator, different from types now in general use. It utilizes principles of radio reception and selectivity in tracing pipes or conduits.

There are three units in the make-up of the new Globe Pipe Finder, all contained in one rugged carrying case. The two main working units, the loop coil and the amplifier unit, are removed from the case and carried by the operator during use. The amplifier may be carried by its handle or it can be worn by the operator on the belt supplied for that purpose, if so desired.

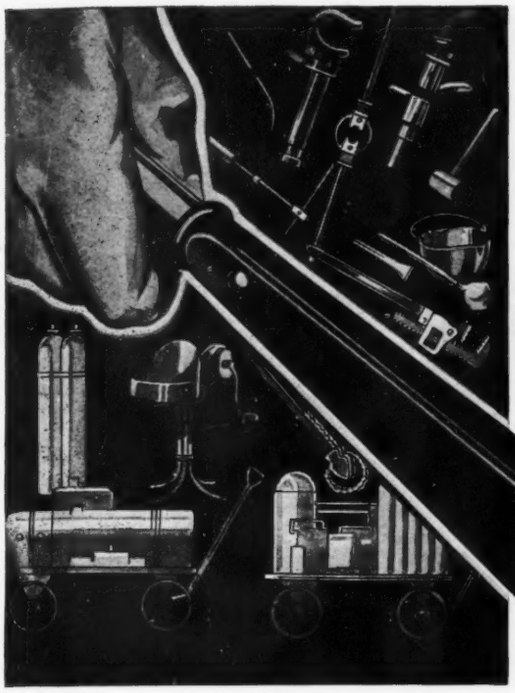


Globe Pipe Finder

The vibrating unit, with its batteries, and also the wire reel, remain in the carrying case. A collapsible handle for rewinding the wire is provided. The amplifier is of the two-tube type with batteries enclosed. All parts of the set are standard and therefore easily replaced when needed. The complete unit is so designed that the equipment can be set up in about two minutes for immediate operation.

The manufacturers state that this improved pipe finder has been proved as to accuracy of operation, dependability and selectivity in locating and tracing a particular pipe line. And although many other pipe lines may be in the near vicinity, there will be no confusion.

For more detailed literature or further information, address Globe Phone Manufacturing Corp. (Pipe Finder Division), Reading, Mass.



How Many Tools Does It Take to Make a Joint?

Just ONE —when you use DRESSER COUPLINGS

Only one tool is needed to install a Dresser joint—a Ratchet Wrench to pull up the bolts. This one tool completely eliminates the need for noisy, expensive, complicated jointing equipment that involves heat or power. • With Dresser Ratchet Wrenches and Dresser Couplings, unskilled labor can make permanently, ABSOLUTELY tight joints in minimum time. Manual operation of a Dresser Wrench requires very little effort and is exceptionally fast. The resulting tightness of the joints never fails to impress the engineer who has experienced difficulties with other types of construction.

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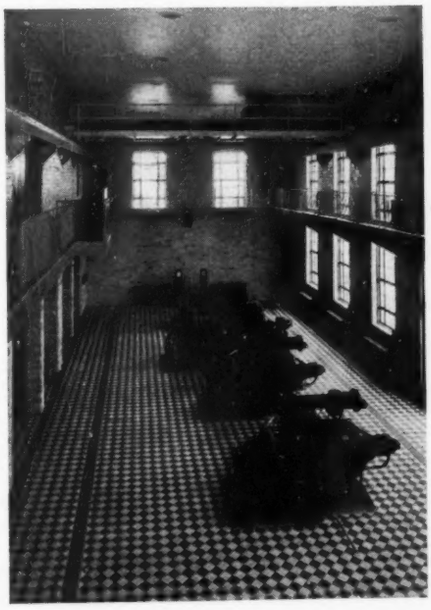


ERIE, PENNA.

Inconspicuously located at the back of the picture are two Type M Venturi Meters which help the operators guard the efficiency of their pumping station.

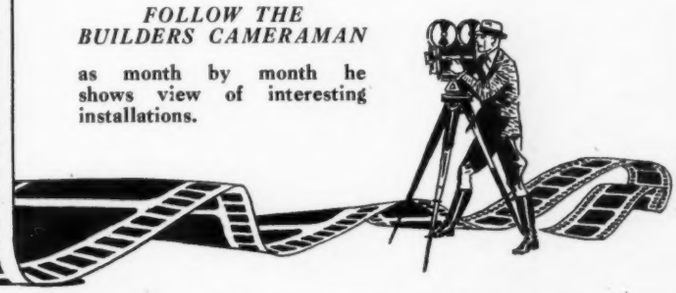
Builders Venturi Meters, Controllers and Gauges have the habit of performing "conspicuous service inconspicuously!"

When you get the same kind of reports from literally thousands of water works and filtration plants there must be some truth in it!

Many an Engineer has found it worth while to discuss his metering and controlling business with this organization; it is probable that we can help you, too.

FOLLOW THE BUILDERS CAMERAMAN

as month by month he shows view of interesting installations.



BUILDERS IRON FOUNDRY

9 CODDING STREET PROVIDENCE • R • I •

Bulletin 260 — Venturi Meters for Main Pipe Lines
Bulletin 232 — Venturi Direct Acting Controllers

Bulletin 273—Chronoflo Telemetering System, transmitting flow, pressure, or level measurements for "hundreds of feet or hundreds of miles."

Yes—we would like you to mention WATER WORKS AND SEWERAGE.

"G. E." Automatic Time Switches

It is becoming increasingly important in sewage treatment and allied practices to arrange intermittent operation of sludge pumps, chlorinators and other mechanical equipment on a timed program basis. Of interest, therefore, are the two recently announced automatic time switches, perfected by the General Electric Company.

G. E. Time Switch

The above illustration (Type T-17) switch is designed to control electrical operations on a schedule set for intermittent operations during any number of minutes and for as frequent periods as desired. This is accomplished by settings of the contact making time dial which actuates a simplified quick make-and-break silver contact through a Telechron motor driven spur-gear train. Small movable riders (see cut) which may be clamped to the periphery of the time dial at selected points operate the switch to create the desired program, no matter what the desired regularity or irregularity may be.

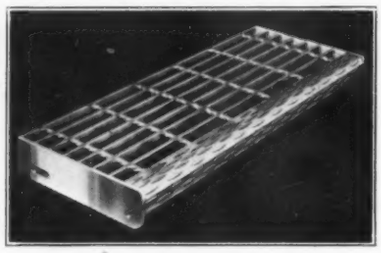
Standard switches are designed for A.C. circuits of 115 to 230 volts and are available in six forms (single throw, double throw and two circuit with separate break) and come with or without the weatherproof case.

For descriptive literature ask for Bulletin GEA-1427D, "G. E. Time Switches." Address General Electric Company, Schenectady, N. Y.

▼

Blaw-Knox Stair Treads

The new Blaw-Knox Electroforged Stair Tread is designed for marked strength against impact. It is now produced with an improved nosing made from rolled diamond checkered plate for increased safety.



Improved Stair Tread

These new treads are made from Blaw-Knox Electroforged Steel Grating, in which the intersections of the bars are electroforged into one piece under extreme pressure, thereby eliminating all loose parts and tendency to rattle.

The twisted crossbar feature affords maximum safety, as the roughened surface of the twisted bar affords a grip for shoe soles, which makes slipping practically impossible even if the tread is wet, greasy or icy. Their construction also lends itself to cleanliness and protection with paint or galvanizing.

For descriptive literature address Blaw-Knox Company, Pittsburgh, Pa.

▼

Col. Rockwell Optimistic Over 1936 Prospects

Colonel Willard F. Rockwell, President of the Pittsburgh Equitable Meter Company, the Merco Nordstrom Valve Company of Oakland, Calif., and the Timken Companies of Detroit, has just completed a trip on which he visited the various plants operating under his direction. Indicating his optimism over present business conditions, he reports that expenditures in the various plants under his management have been authorized to the extent of over a million dollars.

He also reports an expanding export business which takes him to South and Central America at this time.

▼

Catalogs and Trade Literature Received

"Rotary Distributors" — Pacific Flush Tank Co., designers of sewerage equipment since 1893, has just issued a new and attractively illustrated bulletin on "P.F.T." Rotary Distributors for sprinkling filters. It discusses the well established advantages of traveling sewage distributors and sets forth the principles and unique exclusive features of the "P.F.T." type of distributor. Especially are "P.F.T." clogproof Deflector Spreader Jets and also the Mercury Seal, at the base of the central revolving shaft, featured. In the rear is a condensed catalog illustrating 12 sewerage equipment items supplied by "P.F.T." Ask for a copy of "P.F.T." Rotary Distributors" (Bulletin 113). Address Pacific Flush Tank Co., 4241 Ravenswood Ave., Chicago, Ill.

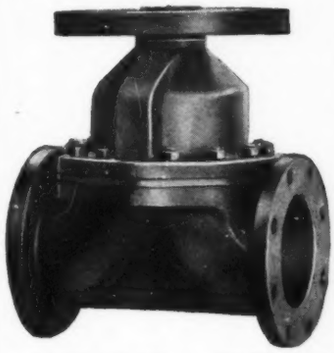
"The Odeeometer"—In a four-page illustrated folder the Advance Engineering Company of Chicago describes the novel Nordell "Odeeometer" and its manipulation. This new piece of apparatus has been designed to determine oxygen absorption (demand) values of sewages and other organic wastes within an hour. Especially is it recommended as a measuring device for quickly revealing the specific *rates* at which oxygen is required by sewages, sludges, or the mixed liquor in activated sludge plants —a very practical consideration in plant operation and control of air adjustments to meet changing conditions. The "Odeeometer" is offered with the idea of advancing the efficiencies and economies in activated sludge plant operation. For a copy of "The Odeeometer," address Advance Engineering Company, 141 West Jackson Blvd., Chicago, Ill.

"The Chicago Comminutor"—A new bulletin by Chicago Pump Company effectively describes their "Comminutor" which is now established in the sewerage field for eliminating the nuisance of handling screenings from sewage, for pump protection and reducing floating solids in settling tanks. The "Comminutor" does the job of screening and shredding of screenings at one operation, and automatically does it odorlessly and away from flies *below* the sewage flow line. Essentially it is a submerged revolving drum screen with ¼ inch spacings between bars. The revolving cutting teeth and stationary comb chop up the coarse solids continuously and render them small enough to pass the slots and settle out as sludge. The new booklet effectively illustrates the design and functions of the "Comminutor," listing a number of successful installations. It does not mention another interesting use to which the "Comminutor" has also been put—namely, as a flash mixer in chemical treatment of sewage, while at the same time performing its normal primary function. For Comminutor Bulletin 128-H, address the Chicago Pump Company, 2336 Wolfram Street, Chicago, Ill.

"Goetze Gaskets"—In an attractively illustrated 64-page catalog, Goetze Gasket and Packing Company presents their complete line of metallic and semi-metallic gaskets, sheet and stuffing box packings, sealing compounds, gasket cutting tools, valve discs, filter screens and metal stampings. Excellent blueprint diagrams, data on sizes and prices make of it a valuable catalog for anyone charged with purchase or use of gaskets and packings. For Catalog No. 48, "Goetze Gaskets," address Goetze Gasket and Packing Company, Inc., New Brunswick, N. J.

"Best Valves for CORROSIVE SERVICE"

STATEMENTS such as the above are regularly made by competent water works and sewerage engineers in reference to the service rendered by Hills-McCanna (Saunders' Patent) Valves.



For chemical, gas or water service they have no equal in point of long life and dependability.

Available in flange or screw types ½" up to 8", with bodies made of alloys, or lined with glass, rubber or lead, to meet specific conditions.

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Does YOUR community suffer from "S-O"?

SEWER ODORS are worse than embarrassing; they're expensive. They cause no end of trouble with citizens naturally indignant at having the community filled with disagreeable odors. But in the lines themselves, the same obnoxious gas, hydrogen sulphide, generates sulphuric acid, which attacks the lime in mortar and cement. As a result, more than one California community has had to replace costly lines completely eaten away by acid.

You can avoid both hazards by treating sewage with Bear Brand Chlorine. Chlorine kills the bacteria which generate hydrogen sulphide and it neutralizes the gas once it has been formed. More than a score of California communities chlorinate sewage for odor control, structure protection and disinfection. Costs are low both for installation of equipment and for upkeep. We'll be glad to send detailed information on chlorination. Just let us know your plant capacity and method of treatment.

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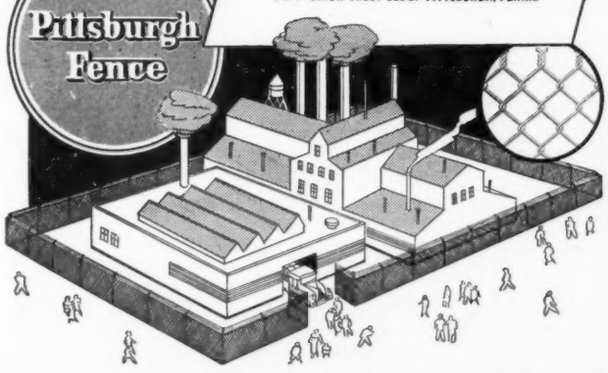


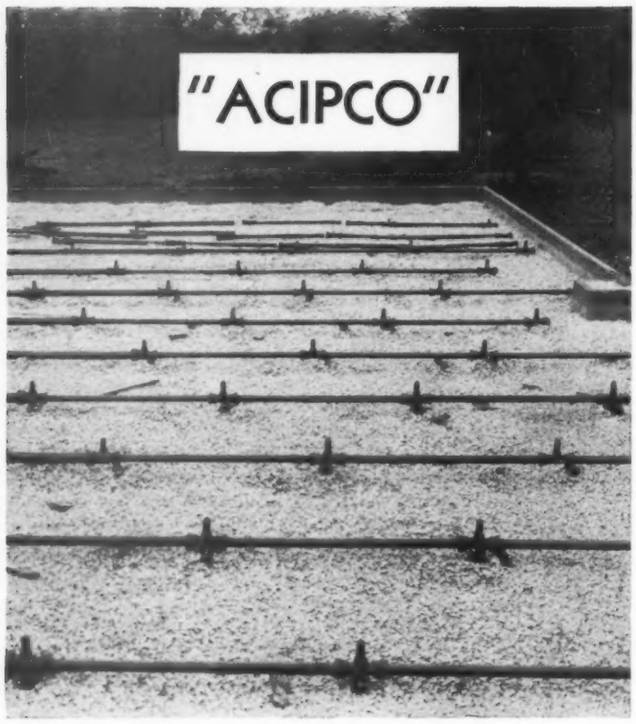
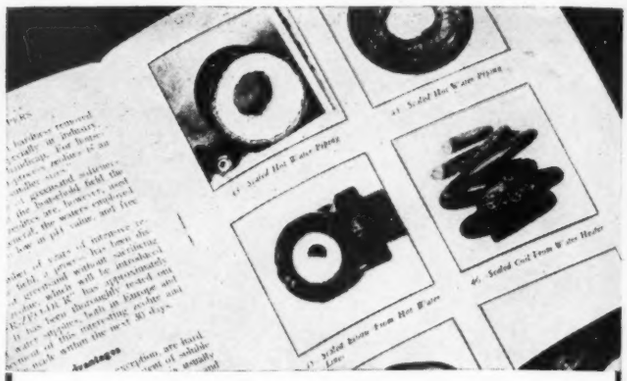


PHOTO shows "Acipco" cast-iron pipe and fittings installed in sprinkling filter of recently completed sewage disposal plant. "Acipco's" manufacturing facilities and organization help simplify sewage disposal plant piping problems. Address American Cast Iron Pipe Co., Birmingham, Ala.



FREE BOOKLET

There are approximately 250,000 zeolite water softeners in this country alone—and yet accurate, up-to-date facts about zeolite have never before been completely set forth.

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Water Conditioning Equipment

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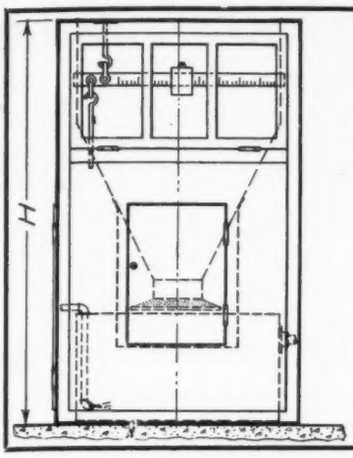

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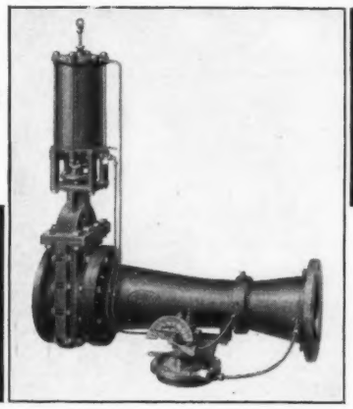

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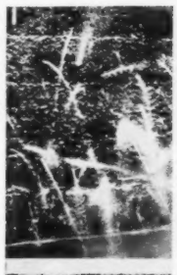

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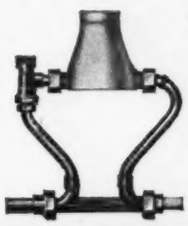

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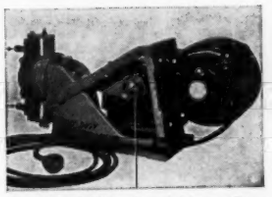

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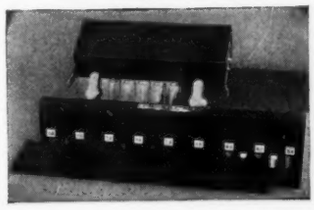

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THE INTERESTS of the Canal Lining Company, Inc., in United States Patent No. 480,838 and United States Patent No. 1,776,941 will be sold at public auction at the Court House in the City of Allentown, Pennsylvania, on December 20th, 1935, at 1:30 p. m. Also License Agreements covering the same patents. These patents cover improvements in Ditch Plows and improvements in Ditch Trimmers. Further information to those interested can be secured by writing to Canal Lining Company, Inc., Allentown, Pennsylvania.

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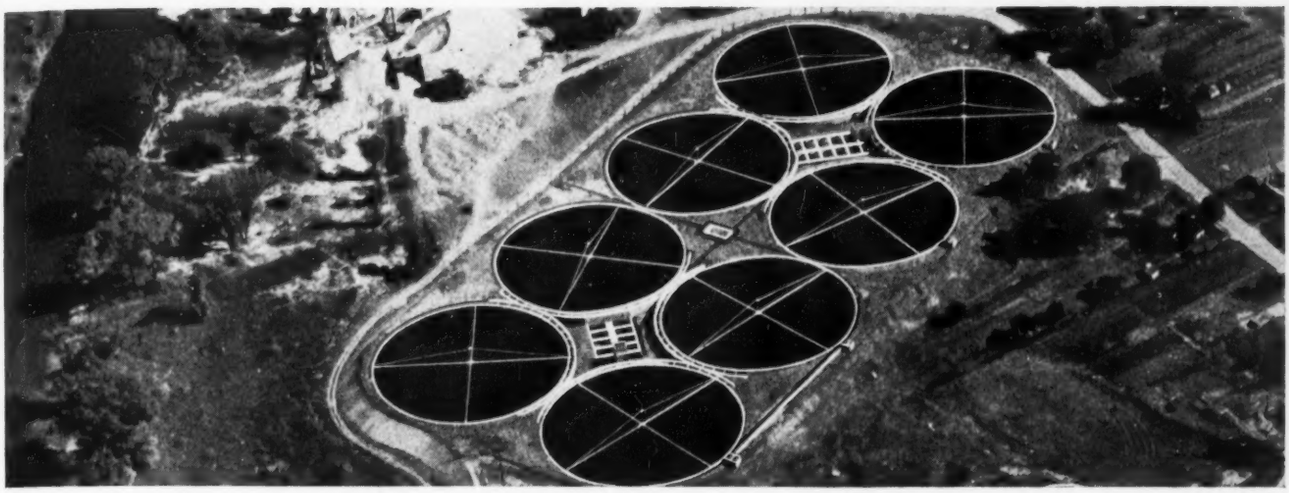

Aerial view of Cedar Rapids trickling filter installation. Eight 167 ft. Dorrco Distributors used.

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No. 2	626	99.52	−0.48
No. 3	636	101.11	+1.11
No. 4	626	99.52	−0.48
No. 5	634	100.79	+0.79
No. 6	620	98.57	−1.43
No. 7	613	97.46	−2.54
No. 8	647	102.86	+2.86
Av.	629		

- The greatest variation from the average rate of delivery was +2.86 per cent and the average variation for all 8 trickling filters 1.2 per cent.
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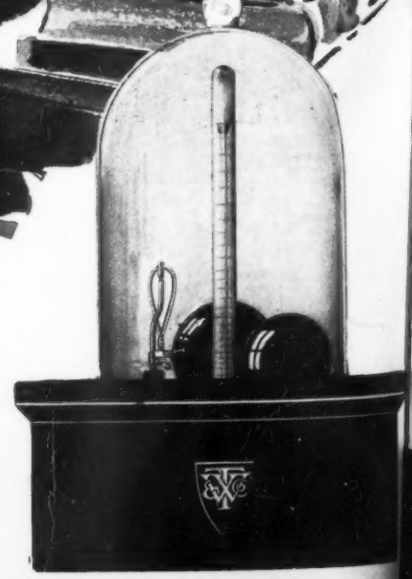

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